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Adam Gnatowski, Mateusz Chyra
Częstochowa University of Technology, Department of Polymer Processing
Al. Armii Krajowej 19c, 42-201 Częstochowa, Poland, gnatowski@ipp.pcz.pl

INFLUENCE OF PROCESSING PARAMETERS ON PROPERTIES OF POLYAMIDE FILLED WITH GLASS BALLS

Abstract
Comparative analysis of thermomechanical properties of polyamide and polyamide composites with addition of 30% of glass balls was performed. The specimens were obtained using the injection moulding technology by means of KraussMaffei KM65-160C1 injection moulding machine. The non-filled polyamide and part of components were injected using the parameters recommended by the manufacturer. A reduced value of mould cooling temperature was used for the other non-filled specimens. The differential scanning calorimetry (DSC), hardness testing, impact strength testing, bending resistance and dynamic mechanical thermal analysis (DMTA) were also performed.

Keywords
Polyamide, composites, glass balls, thermomechanical properties

Introduction

Composite materials on polymer matrix have been frequently used in various sectors of the industry. This is caused by the opportunities for improving mechanical properties of the base material and reduction of the price of final products through lower consumption of the polymer [1-3]. Polyamide belongs to the group of nitrogen plastics. Polyamide is a structural material used for manufacturing of e.g. cogwheels, bearings, bolts etc. It is often modified with such additions as glass fibre or graphite. These fillers significantly improve strength properties of the composite [4-6].

Investigations made so far follows that addition of glass beads to the polyamide makes possible to producing a polymer composite with significantly more favorable thermo-mechanical properties compared to unfilled polymer [7]. An essential problem in processing of composites using the injection moulding method is to select adequate process parameters. Insufficiently low value of injection temperature may cause e.g. incomplete filling of the form, depression on the moulded piece surface or improper clamping force. On the opposite, the material with excessive temperature may be degraded. An important point is also the value of mould temperature. The increase in this parameter leads to the increase in the crystallinity degree of semicrystalline materials, which substantially affects mechanical properties of the moulded piece. However, excessively high value of mould temperature may cause degradation of the material [8-10].

The aim of this study was to analyse the effect of processing conditions on thermomechanical properties of polyamide 6 with addition of 30% of glass balls. Schulnamid 6 GB30H was used as a material for the examinations. The differential scanning calorimetry (DSC), hardness testing, impact strength testing, bending resistance and dynamic mechanical thermal analysis (DMTA) were also performed.

Research methodology

Polyamide 6 (with commercial name Schulnamid 6 GB30H manufactured by Campus Plastics) was used in the study. Glass balls with the diameter of 20 µm were used as a filler. The specimens were obtained using the injection moulding technology by means of KraussMaffei KM65-160C1 injection moulding machine.
The specimens made of non-filled polyamide and the polyamide with addition of 30% of glass balls were examined. Injection moulding was performed at variable cooling temperature (see Table 1).

Table 1. Parameters of sample processing

Samples	*Mould Temperature [°C]*	*Injection Temperature [°C]*	*Injection pressure [MPa]*	*Holding pressure [MPa]*	*Holding time [s]*	*Cooling time [s]*
PA	90	280	100	45	20	15
Composite I	40					
Composite II	90					

Source: Author's

Differential scanning calorimetry was performed using NETZSCH PC 200 machine. The specimens were weighted by means of the SARTORIUS scales with precision of 0.01 mg, internal calibration option and closed weighing space. The mass of the specimens ranged from 7 to 12 mg. The DSC curves were recorded during heating of the specimens with the rate of 10 °C/min within the range of temperature from 35 to 250°C. The crystallinity degree and value of temperature of physical transitions was evaluated using NETZSCH software. This software allows for examination of the profile of specimen melting at the given temperature range and determination of the surface area between the thermographic curve and the basic line in the range of endothermic reflex. The degree of crystallinity (Sk) of the filled specimens was calculated based on the following equation [11]:

$$S_k = \frac{\Delta H_m}{w_c \Delta H_k} 100\% \quad (1)$$

where:
ΔH_m – enthalpy of fusion for the material examined,
ΔH_k – enthalpy of fusion for the completely crystalline material (value taken from Netzsch software),
w_c – mass fraction of homopolymer added to the composite examined

Hardness testing was carried out using the ball indentation method. Charpy impact test was employed for evaluation of the impact strength using the pendulum hammer 5 J. Before the test, an A notch was cut out on the specimens. The static bending test was carried out by means of the strength testing machine Inspekt Desk 20 (Hegewald&Peschke). Analysis of dynamic thermal properties was performed using NETZSCH DMA 242 device with a holder for three-point free bending of the specimen in the form of a beam with dimensions of 50x10x4 mm. The specimens in the holder were subjected to sinusoidal force with the frequency of 1Hz and 10Hz with constant amplitude while heating the specimens at the rate of 3°C/min from 25°C to 160°C. The value of the storage modulus E', loss modulus E" and mechanical loss coefficient tgδ were calculated based on the values of forces and strain with regard to the dimensions of the specimens.

Results and discussion of research

Results obtained for differential scanning calorimetry are presented in Table 2 and Figs. 1 and 2.

Table 2. Results of DSC investigations

Samples	*Degree of crystallinity [%]*	*Melting range [°C]*	*Max. Melt temperature [°C]*
PA	26,07	213,6 – 231,2	226
Composite I	26,80	217,5 – 228,1	223,4
Composite II	28,04	215,7 – 226,4	222,6

Source: Author's

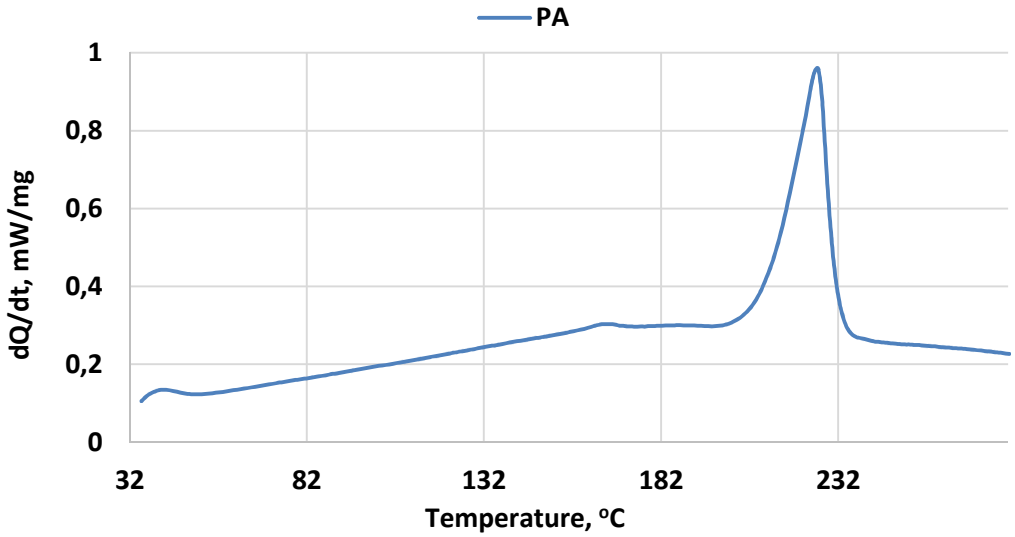

Fig. 1. Thermogram of polyamide.
Source: Author's

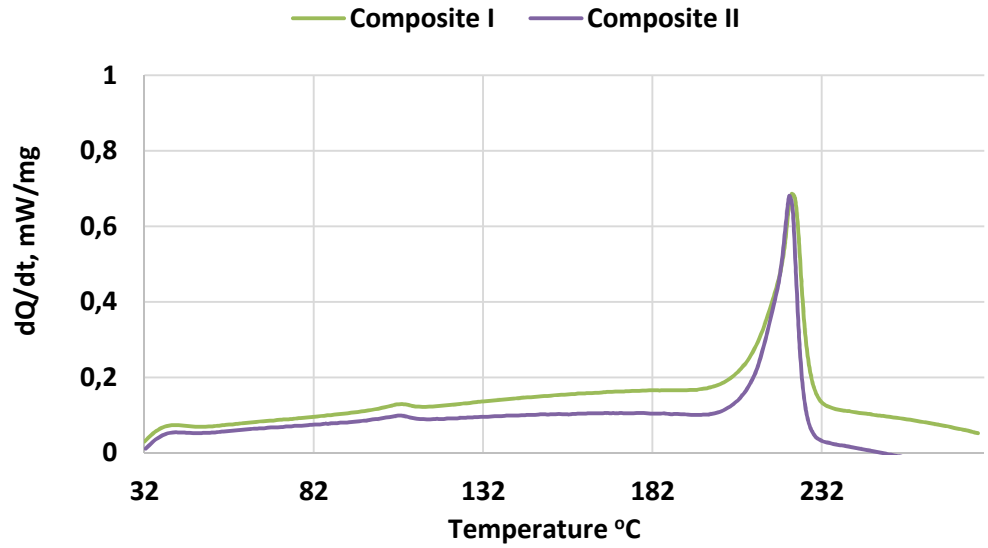

Fig. 2. Thermogram of composites.
Source: Author's

The highest range of melting points was observed for polyamide without filler. The range of melting of the crystalline phase was narrowed for the specimens filled with glass balls. The highest temperature with maximum melting peak was also found for the non-filled material. Addition of the filler caused a decline in the value of this temperature.

For the composites marked as I and II, an increase was observed in the value of the degree of crystallinity compared to the specimens made of non-filled polyamide. This is caused by the effect of filler, which, when cooled down, leads to the formation of the centres of nucleation, which impacts on the increase in the content of the crystalline phase of the polymeric matrix in the composite [12]. The highest value of the degree of crystallinity was observed for the specimen denoted as II, which is caused by the mould temperature higher compared to the specimen I.

The results of the hardness testing are compared in Fig. 3

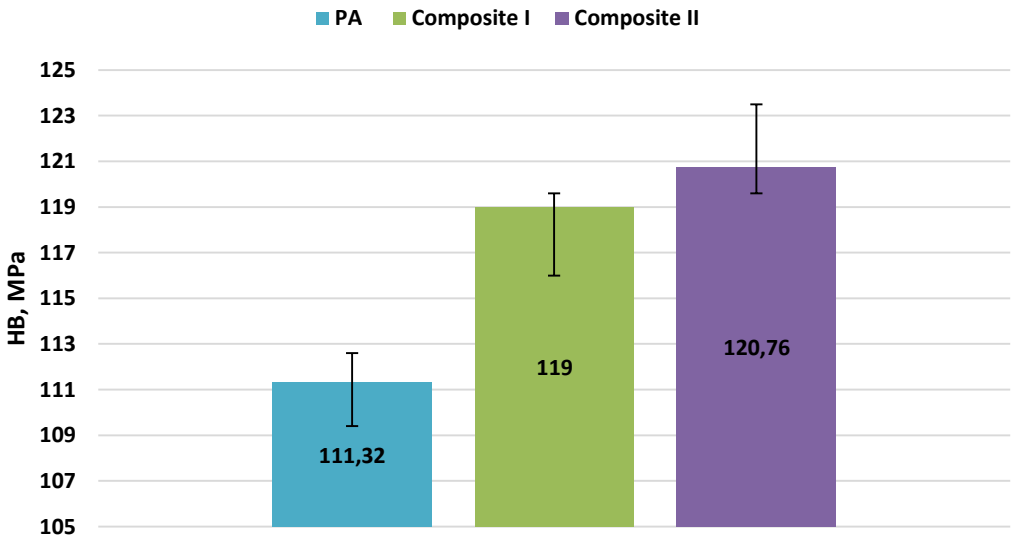

Fig. 3. Results of hardness investigations
Source: Author's

The lowest hardness was observed for the non-filled polyamide. The the presence of glass balls substantially improved hardness of the specimens. The highest hardness was recorded for the composites injected to the mould with temperature of 90°C. Slow cooling rate and the related increase in the degree of crystallinity also impacts on the increase in the hardness of polymeric matrix.

The results of the impact tests are presented in Fig. 4. The highest value was found for the specimens made of non-filled polyamide. It was found that the composite specimens showed a noticeable relationship between impact strength and mould temperature. Lower impact strength was observed with respect to the material without filler for the specimens made in cooler moulds. Reduced impact strength was also found in the specimens injected in the same conditions as polyamide without filler, which represented a decline in the value by 50% compared to the non-filled plastic.

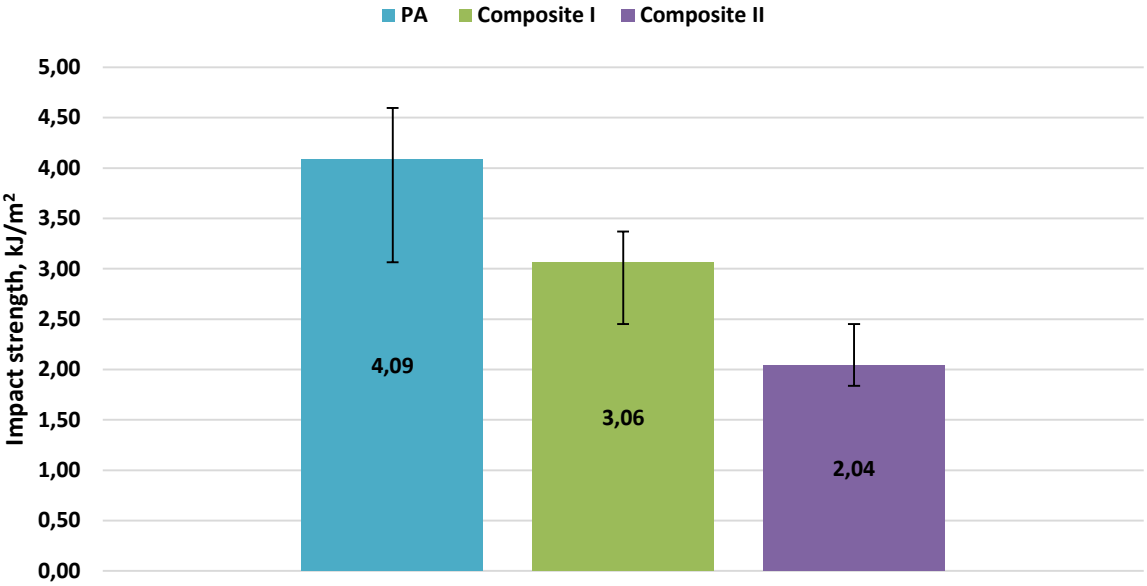

Fig. 4. Results of toughness investigations
Source: Author's

Figs. 5 and 6 illustrate the results of the bending strength measurements. The increase in the bending strength was found for the composites with glass balls. Furthermore, the correlation between this property and mould temperature is insignificant.

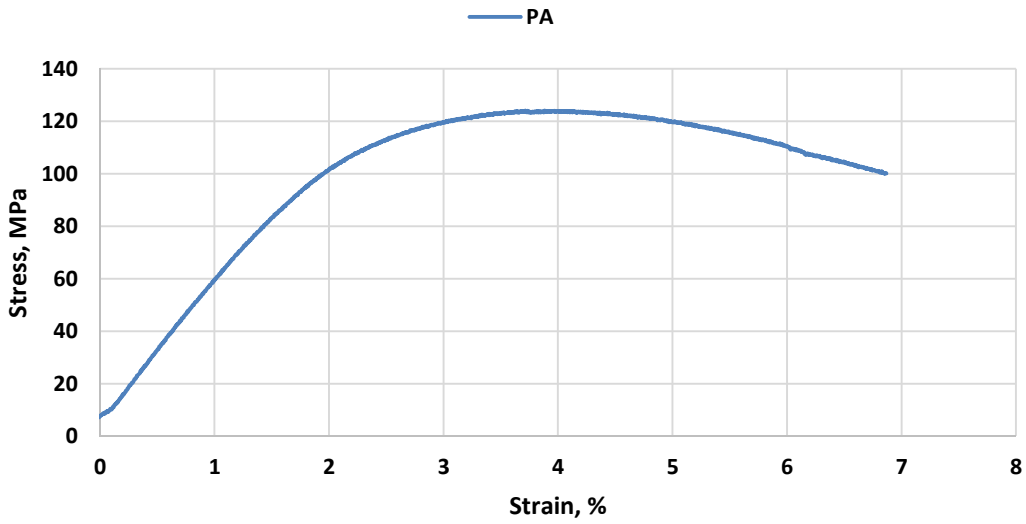

Fig. 5. Results of bending strength investigations of polyamide
Source: Author's

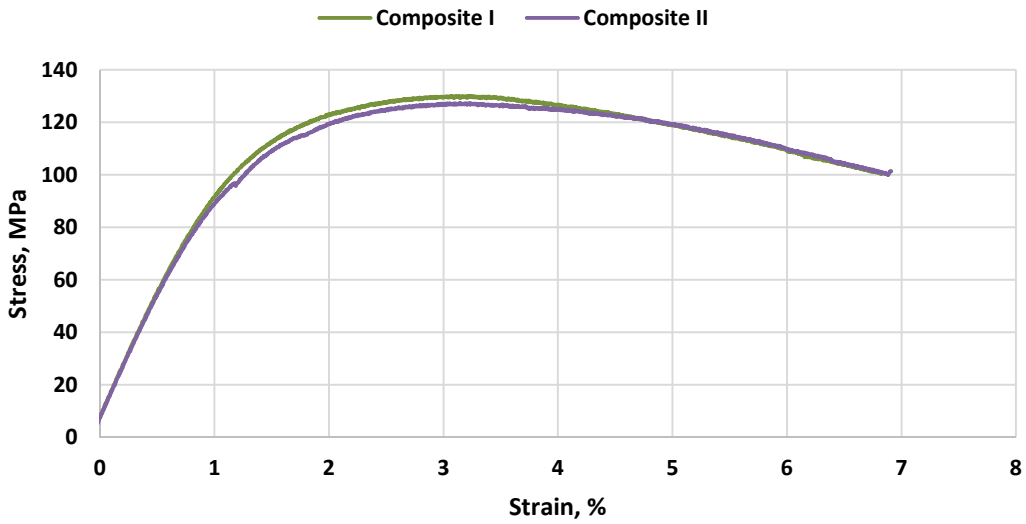

Fig. 6. Results of tensile bending investigations of polyamide of composites
Source: Author's

The results of the dynamic mechanical properties analysis are presented in Figs. 7, 8 and 9. The diagrams illustrate changes in storage modulus and tangent of mechanical loss angle depending on temperature at the frequency of 1 and 10 Hz.

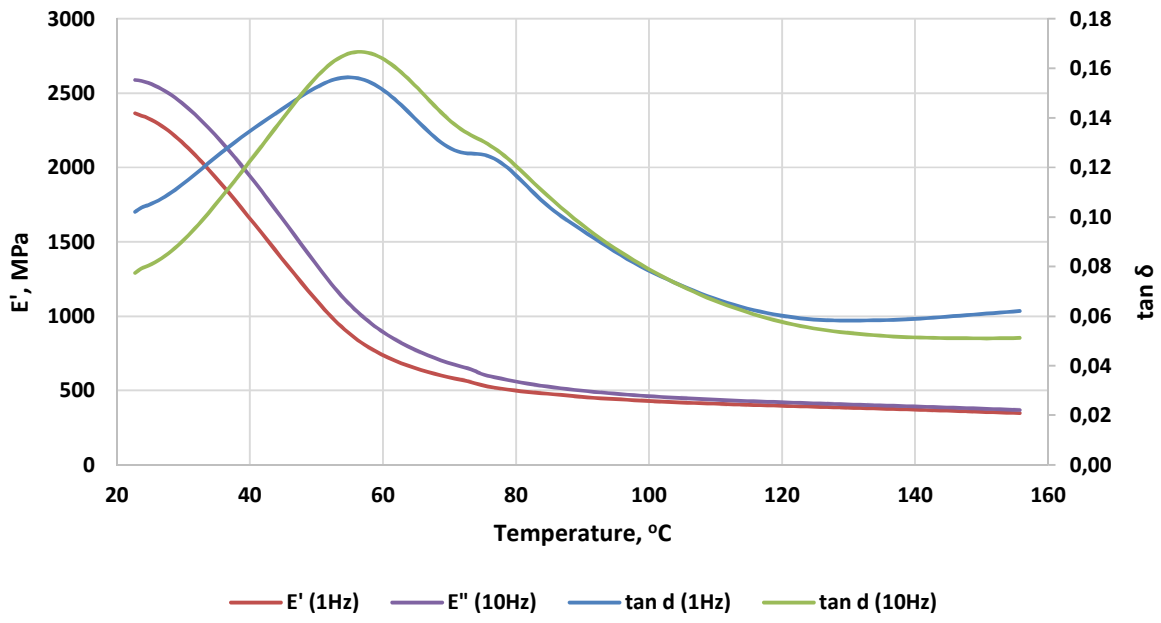

Fig. 7. Results of DMTA investigations of polyamide
Source: Author's

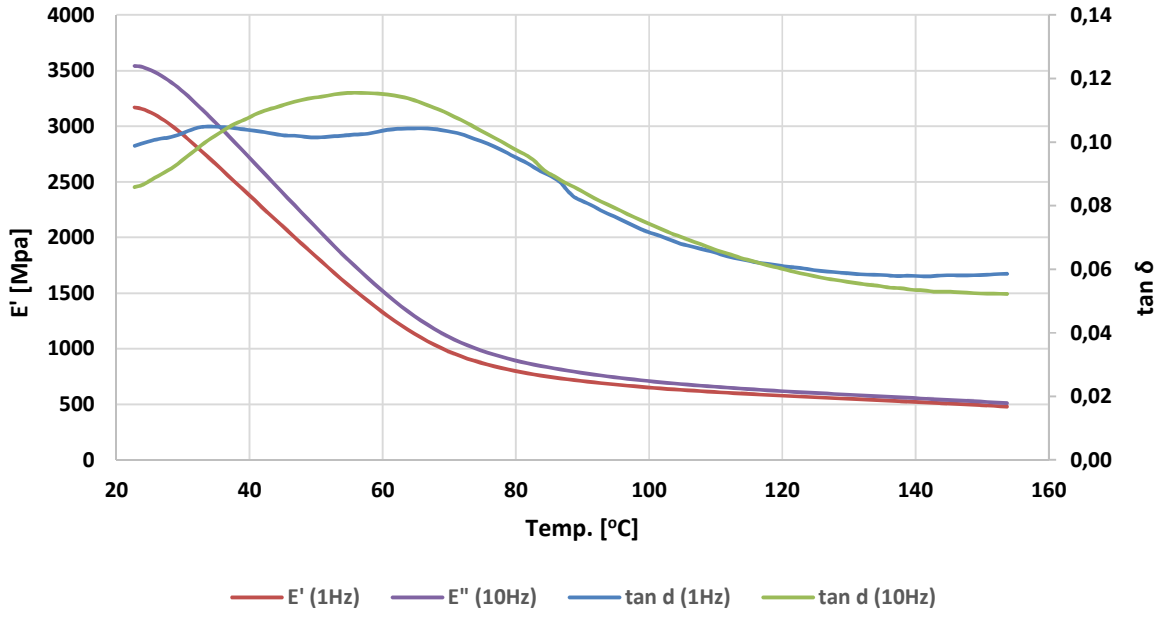

Fig. 8. Results of DMTA investigations of composite I
Source: Author's

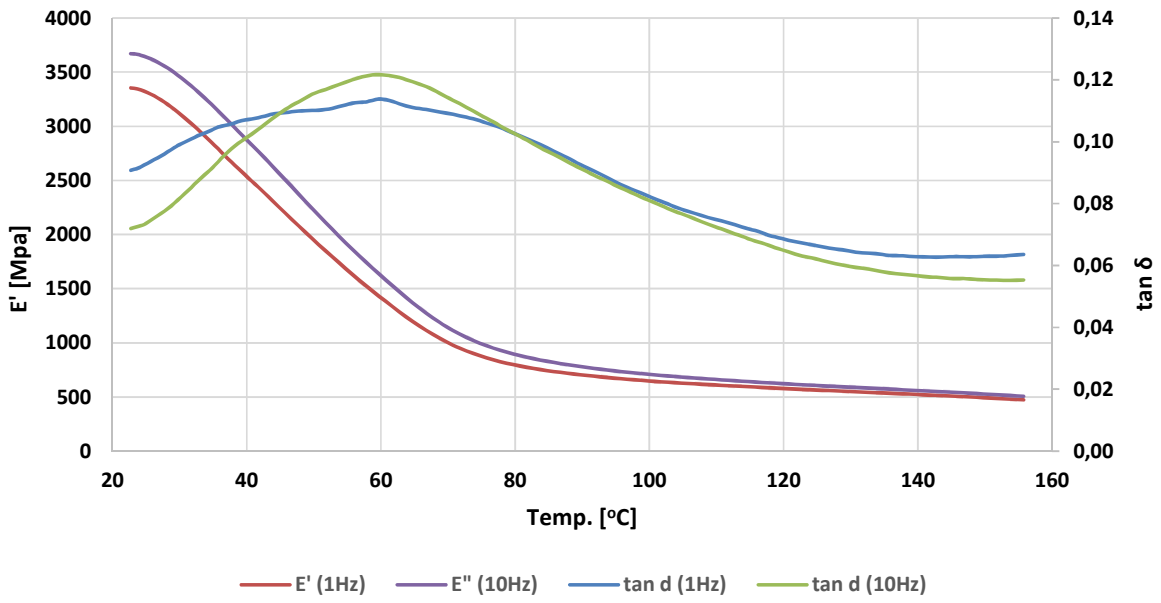

Fig. 9. Results of DMTA investigations of composite II
Source: Author's

The character of curve profiles is the same for all the specimens studied. However, changes concerning the value of storage modulus can be observed. For the specimens containing glass balls, the values of E' are substantially higher than for the non-filled material. This increase is noticeable over the whole temperature range. However, it is the highest in the functional temperature range and reaches ca. 700 MPa. In the phase of high-elastic strain, the difference is not very significant. Changes in the tangent of mechanical loss point to the increase in stiffness of the composite and to vibration damping. The analysis also revealed that the reduction in the mould temperature to the value of 40°C does not cause significant changes in the dynamic properties of the materials studied.

Summary and conclusions

Analysis of the results showed that the reduction in the injection mould temperature from 90 to 40°C does not have a significant effect on the properties of the polyamide composites with glass balls. The composites injected at reduced mould temperature were characterized by lower values of the degree of crystallinity and hardness. However, these differences were insignificant. It was found that lower value of mould temperature has a positive effect on specimen impact strength. No effect of mould temperature on bending strength was observed for the composites analysed. Similarly, no bigger changes in the storage modulus were found during examinations of dynamic mechanical properties. Injection of polyamide composite with glass balls with reduced mould temperature allows for shortening of production cycle time and reduction in energy consumption connected with heating of the mould to higher temperatures, consequently leading to a less harmful effect on the environment.

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Dominik Grzesiczak, Przemysław Postawa
Częstochowa University of Technology, Department of Polymer Processing
19c Armii Krajowej St., 42-200 Częstochowa grzesiczak@ipp.pcz.pl

CHARACTERISTICS OF STRENGTH AND STRUCTURE OF PE - HD COMPOSITE WITH ADDITION OF PE – HD WASTE

Summary
This article presents the possibilities of using the waste material obtained from the vehicle fuel tank (high density polyethylene PE- HD) as an addition to products. The waste material is added to the original polymer in an amount of 10% , 20% and 30%. The following tests have been performed during the research: differential scanning calorimetry DSC, static tensile test, hardness degree determined by pressing a steel ball, and also optical microscopy of obtained breakthroughs in samples made of liquid nitrogen. In addition, there has also been performed an analysis of mixture of original polyethylene that contains 10%, 20 % and 30 % of HD - PE polymer, which has been turned back for recycling from the production line. The aim of the research is to determine the recycling possibilities of polymeric materials obtained from the waste that emerged on the production line and in the fuel tanks of vehicles which were withdrawn from use as materials that during the utilization process have been subjected to a long-term connection with petroleum. Description of the mechanical and structural properties is an attempt to answer the question concerning usefulness of polymeric materials after utilization.

Keywords
recycling, polyolefin processing, automotive components, HDPE processing, types of recycling, recycling of automotive components

Introduction

Dynamic development of polymeric materials and a wide range of their physical properties explain a rapid increase in their production. In the late 80-s of the last century, world production of polymers was equal to steel production. However, since 1990 the amount of polymers produced has exceeded the produced amount of steel. Polymers have won their popularity in the market due to their wide range of both physical and chemical properties, owing to a huge number of variations as well as numerous possibilities of their modification [1-6].

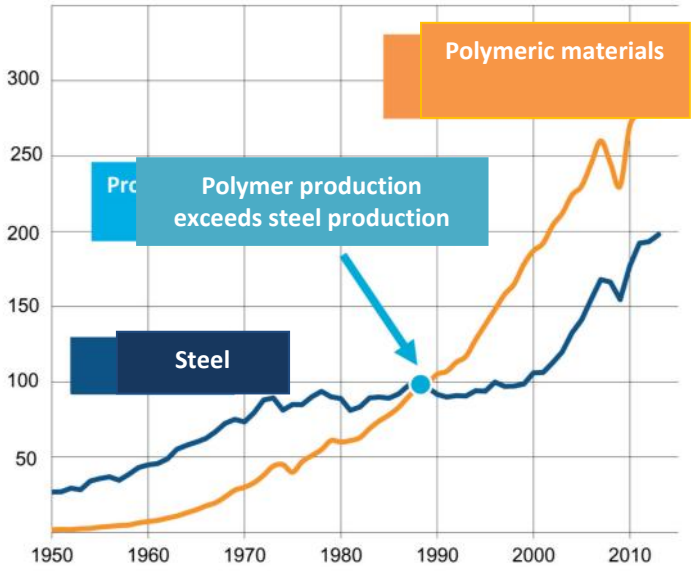

Fig. 1. The global increase in the production of polymers and steel since 1950.
Source: [3]

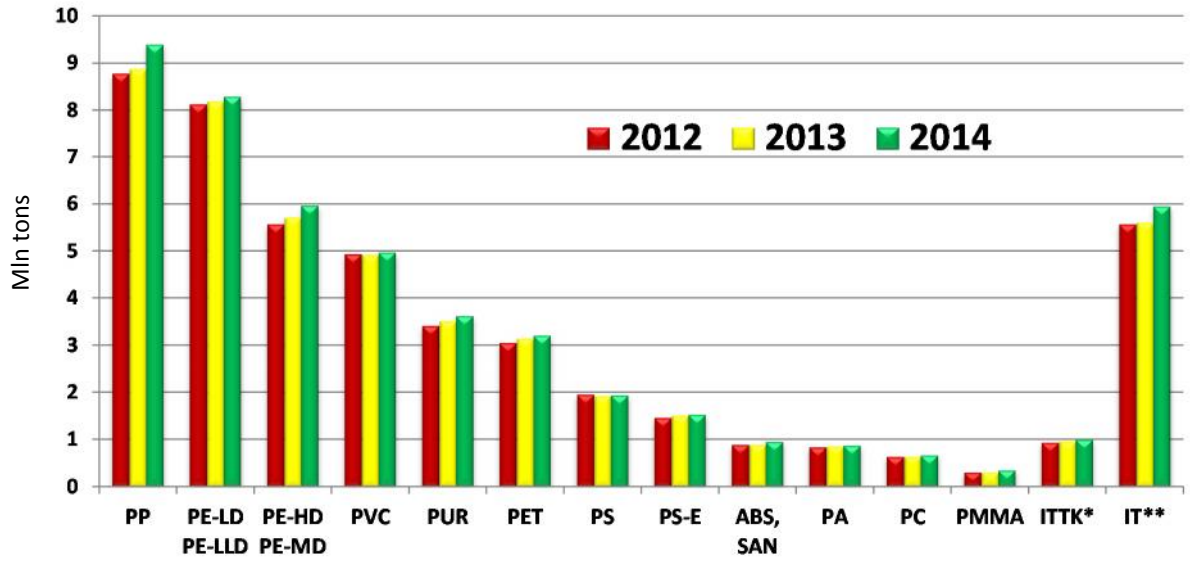

Fig. 2. Growth of demand for different types of polymers, where: *Other Thermoplastic Construction Polymers, **Other Polymers.
Source: [7]

But there is a problem concerning the waste management after production. Nowadays, the most popular solution is storing the waste materials, but the current EU Directives impose a ban on storing the waste materials in landfills, which is tantamount to their re-processing. An alternative to the defaulting on landfills polymers is recycling, which is a privileged recovery system because of the origin of molecular compounds from non-renewable raw materials.

More companies are pursuing a policy of re-use of waste products by shredded and recycling them to the production line, as mentioned by Bociąga E., Magaczewski P. in research work [8].

There are several ways to reuse the waste of polymeric materials:

- material recycling – is about grinding the polymer and then molding it by means of injection or extrusion. As a result, we get a ready-to-use product.
- chemical recycling - is about obtaining simple compounds (monomers) in order to produce some other chemicals. The result of this type of recycling is a substance that has low molecular weight.
- energy recycling – is about using the waste material as fuel in the combustion process in order to produce thermal energy.
- product recycling – is about reusing the polymeric material as a spare part.
- organic recycling – is about processing of the waste of polymers, which are not generated from petroleum. As a result, organic matter is obtained as well as water and carbon dioxide or methane, depending on the method of cultivation [8-18].

Material, research methodology and sample preparation

The aim of the research was to analyze thermal and strength properties of high density polyethylene with the addition of PE-HD waste from the production line and ground fuel tank (10, 20 and 30%). The normalized testing samples (type A1) were prepared using an injection molding machine Krauss Maffei KM 65/160/ C1. In the second step the testing samples (type A1) and a fuel tank were shredded together using a low-speed grinder type Shini SG24 series. The next step was to prepare mixtures containing the waste polymer in quantities of 10, 20 and 30%. And as a result, seven samples for the analysis were obtained.

Symbols applied for the research:
HDPE – reference sample obtained after the first injection,
HDPE + x% R0 – a batch of samples with the addition of the fuel tank grinding,
HDPE + x% R L – a batch of samples with the addition of the grinding, which was turned back for recycling from the production line.
x – amount of the added material in the mixture.

Injection parameters during the preparation of test samples:

- Injection pressure: 120 MPa,
- Injection speed: 50 mm/s,
- Holding pressure: 60 MPa,
- Injection time: 1,4s,
- Holding time: 18s,
- Cooling time: 15s,
- Mold temperature: 50°C

The temperatures of individual heating zones in the plasticizing system are summarized in Table 2.

Tab. 2. The temperature of heating zones in the plasticizing system

Number of a heating zone	**1**	**2**	**3**	**4**
Temperature [°C]	215	205	195	185

Source: Author's

Following injection the sample were conditioning in temperature of 23 Celsius degrees by 48 hours. Strength properties were determined by conducting a static tensile test using a Hegewald&Peschke universal testing machine. There were 5 attempts out for each series. The samples were stretched at a speed of 50 mm/min, which made it possible to determine the maximum tension and deformation of the tested samples. The research were performed according to standard PN-EN ISO 527:1998. The strength analysis was performed using a durometer with a spherical cavity (steel ball). The obtained value of the cavity was 132N. The research were performed according to standard PN-EN ISO 2039-1:2004. Due to the heterogeneity of the tested material and to the size of cavity, the Shore D method was omitted.

Thermal analysis was performed on the basis of differential scanning calorimetry using a DSC Phox 200PC Netzsch machine. The test was carried out in a temperature range between 50 and 200°C at a speed of 10 K/min. The results are presented in the form of DSC thermograms and a table that contains characteristic values marked on the cooling curves. The structure of breakthroughs achieved by stretching the samples cooled in liquid nitrogen was also analyzed. The main purpose of using nitrogen was to get a brittle breakthrough. Breaking the samples was omitted due to the complex tension state, in which the upper part of the sample was stretched and the lower one was compressed.

Results of the research and comments

Fig. 3 and 4 show the curves recorded during the static stretching attempt (using the samples containing the grinding from the tank and from the production line). The color black indicates the tensile curves of high density polyethylene with no filler. The color green is assigned to the samples containing 10% of polymer waste; yellow 20%; red 30%. The tension and deformation values are given in the table 3.

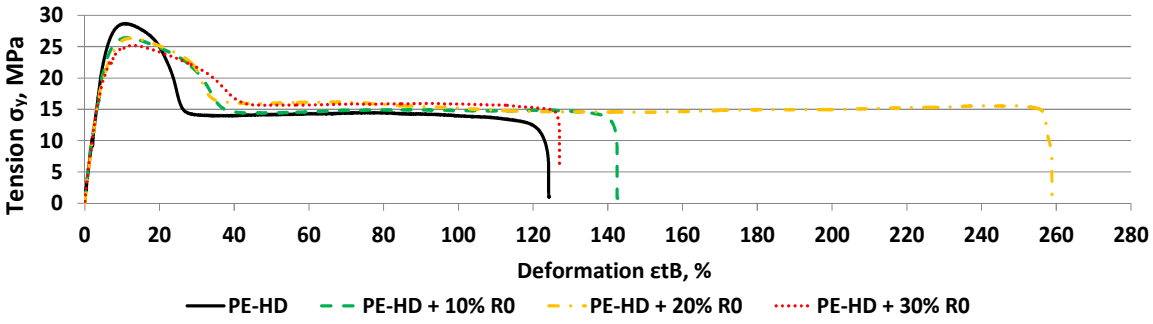

Fig. 3. Tensile curves of high density polyethylene and its mixtures with the addition of the grinding from the tank.
Source: Author's

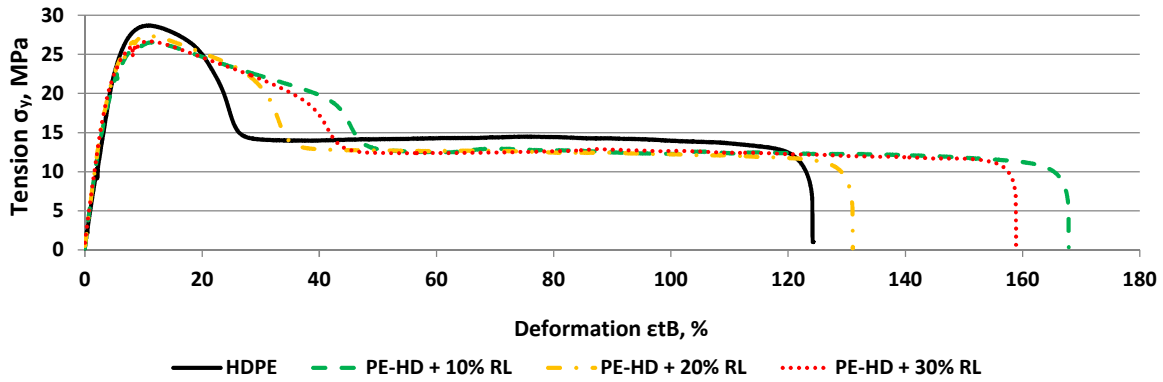

Fig. 4. Tensile curves of high density polyethylene and its mixtures with addition of the grinding from the production line.
Source: Author's

Tab. 3. The PE-HD deformation and tension values, as well as mixtures containing the PE-HD waste with standard deviations.

Symbol	Tension σy, MPa	Standard deviations	Deformation εtB, %	Standard deviations
PE-HD	28.678	0.825	124.01	12.669
PE-HD + 10% R0	26.443	0.243	142.45	10.820
PE-HD + 20% R0	26.364	0.153	258.83	13.832
PE-HD + 30% R0	25.195	0.487	127.02	8.165
PE-HD + 10% RL	26.526	0.437	167.66	7.586
PE-HD + 20% RL	27.334	0.202	130.77	8.228
PE-HD + 30% RL	27.606	1.417	154.49	13.024

Source: Author's

Analyzing the results of stretching, we can observe that the polyethylene sample, which does not contain any additives, has the largest tension value. By gradually adding 10% of the grinding originating from a fuel tank we can observe a decrease of tension. However, when adding the grinding from the production line, we can observe an opposite tendency, which is an increase of tension. Differences between these two values can be caused by the compounds containing fuel, due to which we observe a decrease of tension. While analyzing the RL batch, there has been recorded a growing trend caused by an increase of the amount of filler in the form of thermally degraded material. Deformation values for the R0 batch, on the contrary, have a decreasing trend. However, in both batches we can observe that the deformation values of the samples PE-HD + R0 and 30% HDPE + 30% RL do not correlate with the previous observations. This may be caused by poor homogenization of both polymers since they have a very diverse fractionation. As a result, a larger portion of the waste material is plasticized slower than a smaller one. Figure 5 shows the change in hardness values of individual samples.

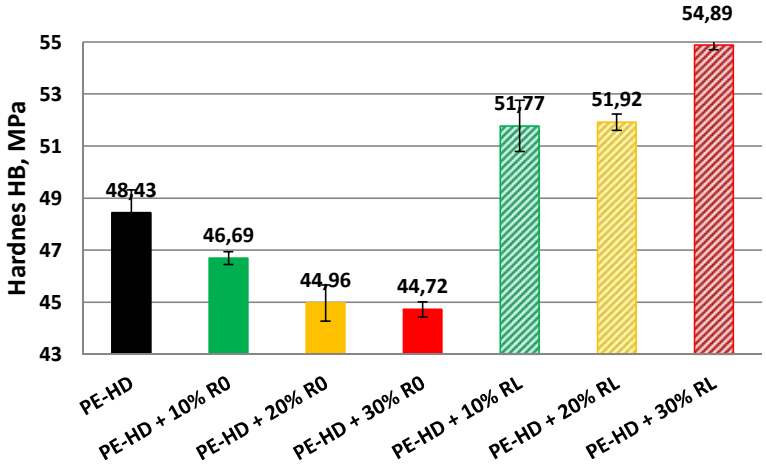

Fig. 5. Hardness values obtained by pressing the steel ball.
Source: Author's

Basing on the research we can see that an increased amount of the HDPE waste causes an increase in hardness of the obtained PE-HD mixture. In case of the R0 batch, an increase of the HDPE waste amount reduces the hardness. On the contrary, the RL batch shows the opposite behavior when the PE-HD waste is added.

Figures 6 and 7 show thermographic curves of the tested batches of samples of the polyethylene and HDPE mixture (HDPE was not subjected to any modifications). The results obtained on the basis of thermograms are summarized below in form of a table (tab. 4).

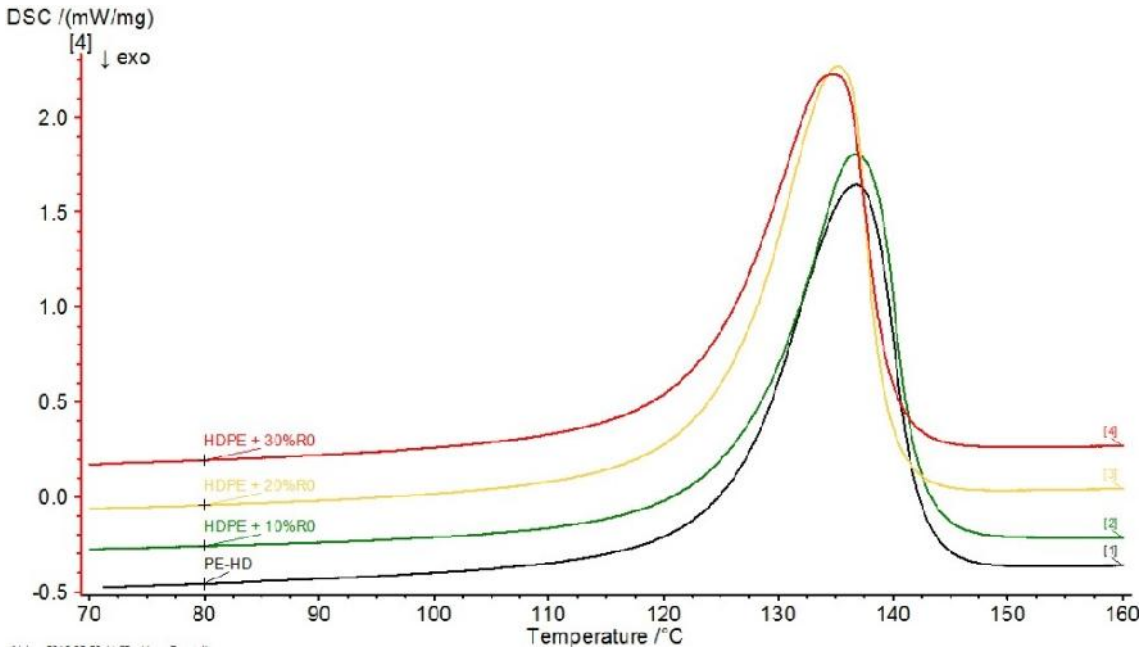

Fig. 6. DSC thermograms of the samples containing the grinding originating from the fuel tank with respect to the unmodified PE-HD.
Source: Author's

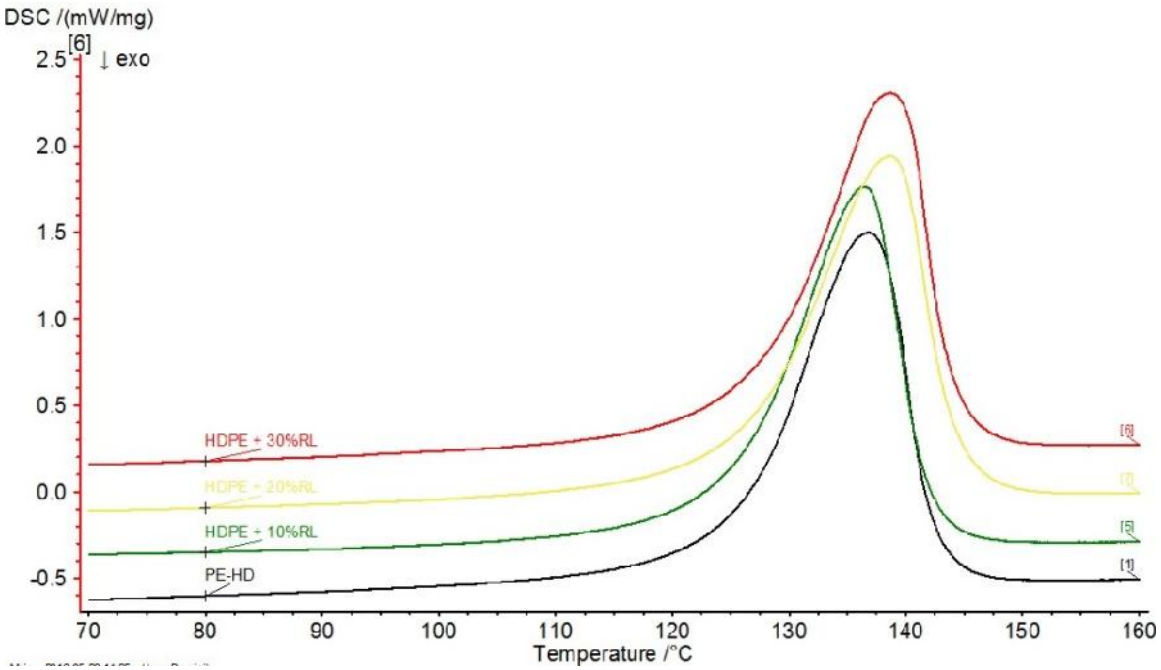

Fig. 7. DSC thermograms of the samples containing the grinding originating from the production line with respect to the unmodified PE-HD.
Source: Author's

Tab. 4. Results of the analysis using the DSC method

Symbol	Melting enthalpy [J/g]	The degree of crystallinity [%]	Maximum m.p. [°C]	Melting range of the crystalline phase [°C]
HDPE	146.9	50.13	136.8	125.8 – 142.3
HDPE +10% R0	144.9	49.45	136.7	126.7 – 142.1
HDPE +20% R0	150.1	51.24	135.2	124.9 – 139.3
HDPE +30% R0	144.5	49.32	134.7	123.6 – 139.9
HDPE +10% RL	145.6	49.68	136.4	125.3 – 141.9
HDPE +20% RL	150.8	51.46	138.5	127.3 – 143.8
HDPE +30% RL	147.5	50.34	138.6	126.5 – 143.9

Source: Author's

Analyzing the results obtained on the basis of differential scanning calorimetry, we may notice only a slight difference between the values of the melting enthalpy, with the value very similar to the corresponding polyethylene without additives. A similar correlation can be stated for the degree of crystallinity. Figure 8 shows the structure of the brittle breakthroughs in the sample of high density polyethylene. Figure 9 shows the structure of breakthroughs in the samples, to which the PE-HD waste from the tank grinding was added in an amount of 10, 20 and 30%. The structure of breakthroughs in the samples containing polymers from the production line is shown in Figure 10.

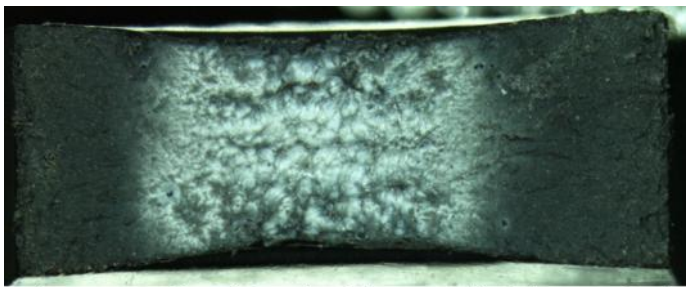

Fig. 8. The structure of breakthroughs of the original high-density polyethylene
Source: Author's

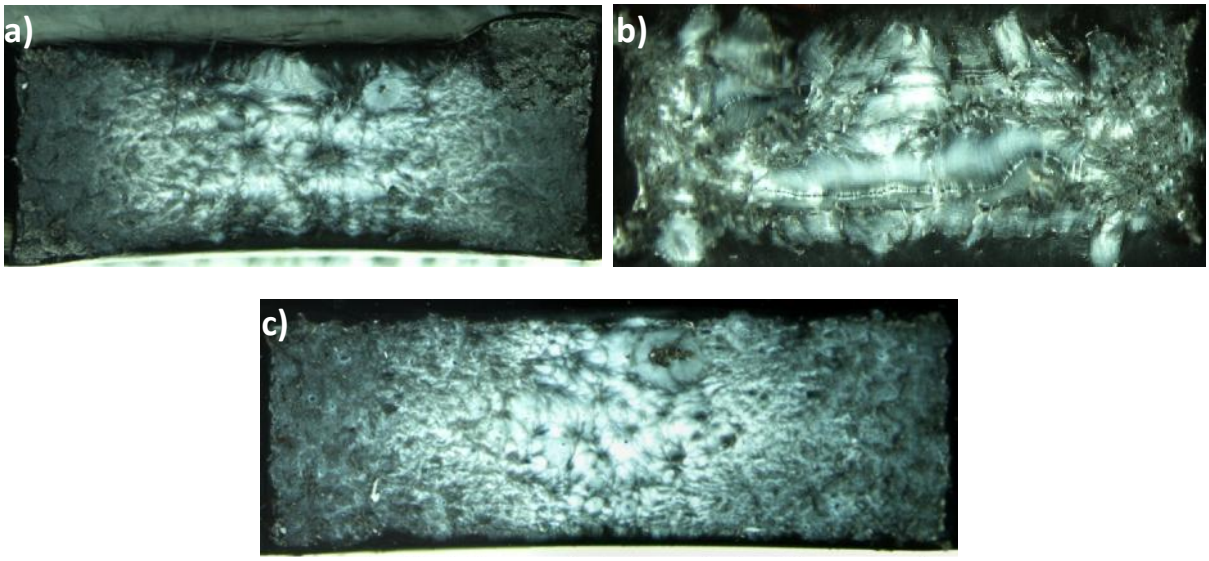

Fig. 9. The structure of breakthroughs of high density polyethylene with the addition of grinding originating from the fuel tank in an amount of: a) 10% b) 20% c) 30%.
Source: Author's

While analyzing these images that show the samples structure we can observe a characteristic bright area which is the core of the sample. Adding the waste material has led to an extension of the mentioned area. Observing the brittle breakthroughs of the samples from the fuel tank, we can notice areas, in which the fragments that have not fully melted.

In the figure 9b) we can see further delamination, or loss of consistency (the crack is formed along the section of the sample located at the bottom of the breakthrough). It should also be mentioned that there are some discontinuities caused by bad homogenization of the base HDPE polymer, which becomes the waste material before filling it back into the machine.

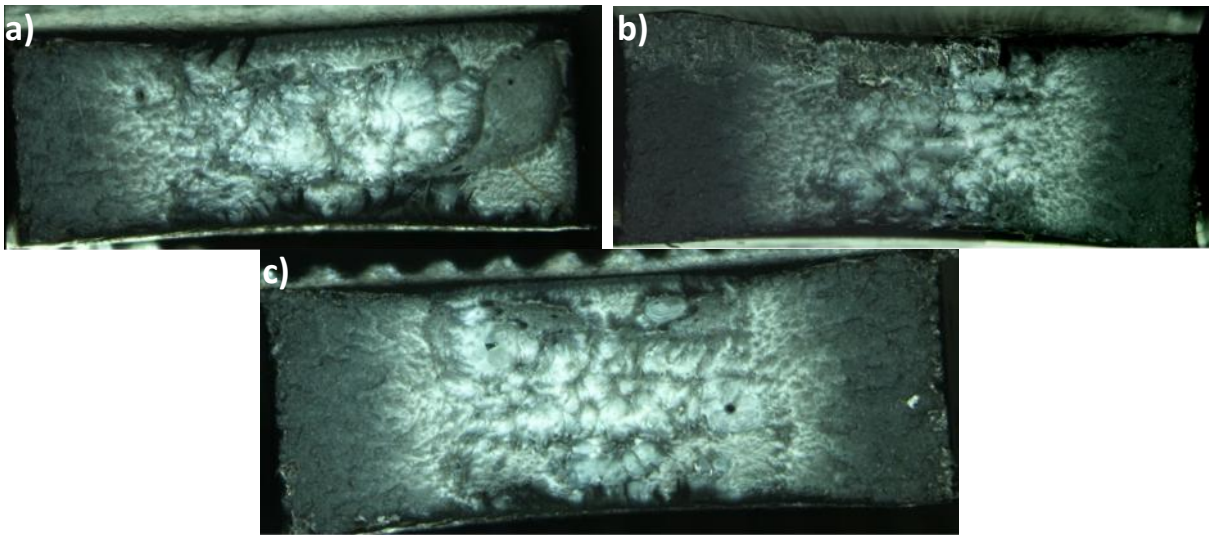

Fig. 9. The structure of breakthroughs of high density polyethylene originating from the production line in an amount of: a) 10% b) 20% c) 30%.
Source: Author's

For the samples containing ground HDPE recycled during the production stage, we can notice the ordered structure containing some particles which were homogenized in a similar way as the base material.

Summary

The research shows that the increase of the amount of additive in the form of ground fuel tank causes a decrease of tension. The waste originating from the production line causes an increase in tension, but the value is still smaller than in case of the base polyethylene. For both batches, we can observe a larger deformation than in case of HDPE, we can see the values increase in the RL batch, and the values decrease in the R0 batch.

Measurement of hardness using a device with a spherical indenter indicates a greater hardness of the samples from the RL batch, which is growing together with increasing of the amount of the waste material added. It should be added that the hardness of the reference sample is lower comparing to the one of this batch. But it is larger than in the R0 batch, where the value decreases while the amount of the waste material increases.

In the case of thermal analysis using the DSC method, there were no significant changes in the melting enthalpy and in the degree of crystallinity, which could only slightly change when there was a value close to the one assigned for a base polymer.

Analysis of the structure of brittle breakthroughs points on the problem of poor homogenization between the particles of the mixture particularly in the R0 batch, and also it points out that the polymer particles might not be plasticized well enough. In addition, a part of the image of the sample containing 20% of filler from the tank illustrates a crack along the cut indicating delamination of the material.

When increasing the amount of the waste material, which has a diverse fractionation, we must carefully adjust the processing conditions associated with its plasticization. This indicates the need to use regranulates instead of regrind for the purpose of stability and repeatability of the physical properties of moldings.

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Andrzej R. Klimek
Research and Innovation Centre Pro-Akademia
9/11 Innowacyjna Street, 95-050 Konstantynów Łódzki, Poland, andrzej.klimek@proakademia.eu

PROSPECTS FOR DISSEMINATION OF NEAR-ZERO ENERGY BUILDINGS (nZEBs) IN POLAND: A PERSPECTIVE OF SOCIOCULTURAL THEORIES

Abstract
Near-zero energy buildings (nZEBs) in Poland seem to disseminate more slowly than expected, even though they will inevitably become a standard, as a consequence of European Union regulations. The paper discusses the barriers already identified, demonstrates ones which have not been further known yet, having deeper sociocultural roots, and aims for providing effective solutions of the problem.

Key words
Near-zero energy buildings, passive houses, diffusion of innovations.

Introduction

Popularization of the nearly zero-energy buildings (nZEBs) is crucial for a global carbon dioxide emission mitigation. This issue has been regulated by EU Directive 2010/31/EU, which makes this standard compulsory in the beginning of 2019 and 2021 for public and residential buildings, respectively. In Poland, although passive edifices of many functions, such various as the church in Nowy Targ or a university indoor arena in Cracow [1], have been erected, they are still often identified with single-family detached houses. The housing sector indeed is important in terms of the success of the entire challenge of limiting the global warming but despite much attention, its development seems to be slow. The prospects for the situation after 2021 are not calming as the implementation of the new standards requires a previous dissemination of know-how, which still cannot be observed in Poland. Until 2014 about 30 Passivhaus-standardized buildings have been opened so far in Poland while in Czech Republic – more than 400 [2]. Inclusion of the non-standardized nZEBs into the statistics would not change them a lot. Therefore some authors, such as Płaziak [3], find the tempo of the transformation within the industry insufficient. Thus, the means of its extra stimulation should be searched.

Significant barriers in the development of nZEBs already identified

Due to the fact that passive housing attracts most of the attention in Poland, its development barriers have been already discussed. Those of them which were found most serious will be described below.

The primary of them are difficulties in finding experienced architects, while they are absolutely necessary from investors point of view. The reason is that investors' capability for taking risk the risk of an unsuccessful project is very low, with elevated costs and technical complicatedness as occur in the construction process. It is strictly connected with the fact that the private patrons have limited budgets and are not excessively generous. As a survey shows, for Polish people financial matters are the main factor for choosing a near zero-energy house, followed by the state co-financing of the project option, while its environmental friendliness is at the third place, mentioned by slightly less than a half of all interviewees [4]. Their cost-cutting approach has a consequence in an expectation of schemes intended for multiple replication, sold by means of catalogues [5], further named as 'catalogue houses'. The strategy of multiplying well-proven solutions and offering low prices this way was identified by Coxe et al. as one of three basic strategies of functioning of the architectural firms and called by him 'strong-delivery' [6]. Although it can be as financially profitable as others, the problem is that it is found least prestigious in the entire industry and extremely hard to be brought together with the innovativeness. Due to the fact that most of local architects do not have any practical experience with nZEBs, the latter must be considered as an innovation in Poland. The strong-delivery strategy is not strictly limited to producing 'catalogue schemes', but such an activity is particularly condemned in architectural circles which deprives it virtually any influence on the field [7]. Therefore, despite the fact that Passivhaus standardization matches the clients' expectations, it still fails to solve the problem of the real experience dissemination amongst designers.

Another strategy characterised by Coxe, called 'strong-service', aims for regular providing technically innovative solutions to the client [6]. IARP (Chamber of Architects of the Republic of Poland) estimates that only 2-4% of practicing Polish architects develop their professional skills [8], which would let us classify them to this category. The strong-service firms wages are also way above the accepted level of an average individual client as they are used to base on the corporate ones. The number of 2-4% of all registered architects is close to the probable amount of the architects in Poland working in the strong-service branch as the third strategy, strong-idea, in Polish conditions is statistically ignorable. The whole situation demonstrates a significant mismatch between the realm of investors and designers.

Another problem, which is also about experience and also requires system solutions, is a need for an exceptionally care in planning, running and supervising the construction process, which proves to be difficult. It is important as passive houses with defects, regardless if they were made by the designer or contractor, have little chance to pass the blower-door air-tightness test or to obtain an energy efficiency certificate. The former is necessary only for obtaining a Passivhaus standard, while the latter is essential for the client not only to prove the planned energy savings, but also in commercial terms, regarding future selling of the object. Another point of uncertainty is the fact that in many cases during the occupancy the residents use more heat than it was established for calculation purposes.

For further analyses it is also good to mention that the land plots for passive houses must be really large, having also many additional specific requirements which have been already described in multiple publications [9, 10, 11]. The problem is that local authorities are not used to take them under consideration in the process of spatial planning [12].

Factors and barriers identified in view of sociocultural theories

Including the achievements of sociology of cultural processes into the analyses of the nZEBs development prospects is legitimated by the fact that they are often exploited in marketing, especially the Everett Rogers' diffusion of innovations theory. As it has been already stated, in Polish conditions nZEBs, as well as the entire renewable energy industry, matches all the features of the innovation and the use of the theory generally aims for fitting the new product properly to the needs of client so it can turn out to be very useful. Better understanding of the sociocultural processes leads to finding new barriers, but also dynamic and efficient solutions which tackle them.

Staniszewska describes main assumptions of the theory of Rogers in the following way: „The fact if an innovation would be sustained or suppressed depends on its features such as:

- Comparative advantage – which depends on how an innovation is regarded as better than existing solutions. This feature does not relate to the objective advantages of a given innovation but to its subjective image in eyes of an individual.
- Compatibility – which concerns how much an innovation is regarded as compatible with the values, norms, and needs of the potential adopters present in a given society. The more compatible an innovation is, the faster is a process of its diffusion.
- Complexity – which describes how an innovation is regarded as hard to understand and implement. The higher level of complexity, the lower tempo of its adopting by individuals.
- Testing possibilities – concern how much an innovation can be proven and checked. Sharing a product or a service with potential customers may significantly enhance the tempo of adopting.
- Tangibility – which describes how much the effects of given innovation can be observed in the environment. As they can be noticed easily, people get acquainted with the solution and are more eager to implement it themselves." [13]

In present situation of nZEBs in Poland the incentives for small clients appear unsatisfactory, even though without them the breakeven point of the investment would be delayed for several years. Thus, their comparative advantage turns out rather vague, as it requires planning the timeframe of more than twenty upcoming years, which brings too many variables and uncertainties. This explains why so many people driven by a conscious calculation, similarly as passive housing investors, paradoxically in the same time choose traditional houses. It would be much better if investors made the same decision convinced by the environmental arguments, of course avoiding any excessive expenses. The problem is that the assertion that

previous economic development was based on the exploitation of free natural resources is still found controversial in Poland, and so is a process of calculating and vindicating the ecological costs, which is absolutely crucial for creating a comparative advantage for nZEBs.

Moving forward to the compatibility, neither ecology or thriftiness is a highly appreciated value in Poland, which would be confessed by the social majority. [14, 15] Currently functioning model, where nZEBs are predominantly single-family passive houses, leads also to further limitations in terms of a lifestyle. It requires living outside big cities, so a dweller in such a house can be either working from home, either working locally and earning above average, either commuting daily to the nearby city center. None of those lifestyles seems to be particularly common in Polish society as there is a clear correlation between the size of the settlement and the average wage [16]. It must be noticed that the latter of those alternatives gains some popularity recently, but the problem is that it is not sustainable. Even regardless of the social capability of the lifestyle adoption, due to the fact that a Passivhaus demands two to three times larger land plot than a standard house, its potential dissemination would eventually lead to an unsustainable growth in a scale of the total amount of built-up areas, with a critical emphasis on the transport network [17]. It is possible in theory, however, such developments would apparently be strongly inhibited by various public bodies which would pay costs of building the new surplus infrastructure. Lifestyle was also an important subject of studies by Pierre Bourdieu, who claimed that the way we live is strongly bound with a distinction, which thoroughly means demonstrating of the social status of individuals, even unintendedly [18]. Hence, it can be presumed that the specifics of passive single-family housing and its strict shape demands do not make it a good material for showing the individuality of the owner, neither predestine it to a role of a status symbol. Of course, some people choosing this form of housing do not feel a need of such a demonstration and this fact can be connected with an aforementioned demand for catalogue passive houses, which have their own limitations. In fact, the form of a nZEB can be shaped loosely, but an extensive nonadherence to the Passivhaus principles leaning towards extravagance causes broad use of active technologies, which is not only expensive, but also inconsistent with the entire idea of sustainability.

As it has been already stated, the Passivhaus standardisation was matching the expectations of clients who need not to distinct themselves but was not very supportive for a potential diffusion of the whole concept among designers, as this group tends to disseminate ideas implemented by authors who have a strong acclaim from peers and critics, such as Renzo Piano or Norman Foster. These star-architects have designed nZEBs quite often lately, but solutions they propose rarely match the Passivhaus standards. Due to such architects' emphasis on tangibility it can be assumed that the new type of building will eventually become popular, but it will probably give the widespread dissemination to a form of nZEB other than Passivhaus. It will also require a long time as the innovation, which is related to global processes and is intended to influence them must be more complex than a new, entirely aesthetical fashion or fad.

All the mentioned reasons show that strong liaisons between current near zero-energy housing and individual investors cause severe problems and build a large development barrier, which would be able to be avoided, if they are replaced by corporate clients in the role of key investors. Housing estates developers proved they can employ strong-service architectural firms, so they are capable of solving the problem of unexperienced designers. Presently such companies are not interested in nZEBs due to their strong orientation on generating income. Therefore, in order to retain their financial liquidity, they aim at minimization of their own expenses, in this case building costs, which entails their lack of strong will to lower the energy bills paid later by their customers. However, creation of a viable system of incentives can change this situation and make them an active subject in the development of nZEBs. Furthermore, generally multi-family housing is per capita more energy-efficient than single-family, so such a solution would presumably bring additional benefits in large scale.

Proposed solutions

Near zero-energy multi-family estates have already been constructed. BedZED (Beddington Zero Energy Development) in London with one hundred flats is a good example. It is worth mentioning as it was designed for tenants with a common approach to the issues of ecology and sustainability and that it had passed an audit after ten years of occupancy, which proved its long-term effectiveness [19].

Basing the entire strategy on such projects would solve several problems described above. The decision if these new edifices would be social or strictly commercial, as presently, is political and does not matter in ecological

terms. Firstly, many land plots of the appropriate sizes have already been possessed by the real estate companies. Their owners would only have to adjust the planned floor area ratio to enhance passive solar heat gains. Apparently it would mean a potential financial loss for them, but a public programme of compensations should be taken under consideration. Such a redistribution of public funds to profit-oriented companies should be good for public realm not only by encouraging nZEBs and thus energy efficiency at large, but also by the fact that such a decrease of a floor area ratio in many cases may increase the quality of urban space. Furthermore, the new strategy would also approach nZEBs to crowded city centers. It would certainly have a positive impact on the discussed innovation tangibility, directly or by means of mass media. It cannot be denied that in urban conditions it would be hard to retain passive solar heat gains on the same level as outside cities. However, entire transport system would be much more sustainable than in a hypothetic case of "passive suburbanization", so that even compensating the lower gains by means of active technologies would appear to be justified.

Another solution which is completely different, but which also should be proposed, is increasing the innovativeness of the architectural firms by improving their organization and by activities aiming at the consolidation of this currently very fragmented market. Even though it would deprive its accessibility for individual clients, the knowledge transfer within would become more fluent. Increasing people's awareness of advantages of living in nZEBs should be also maintained, regardless of any finance-driven programmes.

As Płaziak notices, popularization of nZEBs by decreasing their building costs, regardless of their size, could be reached by implementation of new Polish technologies. The research on new building materials is developed in Poland quite well and the problems appear at the stage of tests as specialised laboratories are relatively inaccessible [3]. Unfortunately, it is a symptom of a larger phenomenon, namely insufficient financing of the research and development sector in Poland. Last but not least, creation of a system of incentives for near zero-energy hotels or guesthouses should be considered, as they would eventually enable many citizens to check how a daily life in a nZEB looks like, before deciding on investment.

Summary

The nZEBs dissemination in Poland is not as fast as expected, even though they provide their owners with many benefits. It can be expected that there is a trouble with a further spreading of their idea because of the fact that their examples are not well established in common consciousness. The industry is developed predominantly by small private investors, who can afford hiring only strong-delivery architectural firms, which are featured by a low absorption of new technologies. Moreover, such clients prefer detached single-family houses, which should not be strongly promoted, as a rapid growth of their amount would not be sustainable. Thus, nZEBs should be developed in cooperation with investors who can afford more complex projects and who presently avoid energy efficient constructions because neither ecology or investments with a longer payback period are not among their priorities. Multi-family developments are a prospective segment of the market, as they can be suited easily to the nZEBs standards and they should be a target of future proposed public incentive programs.

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Monika Smaga
Research and Innovation Centre Pro-Akademia
9/11 Innowacyjna Street, 95-050 Konstantynów Łódzki, Poland, monikaturek@op.pl

QUALITY PARAMETERS OF THE SOLID FUEL PRODUCED FROM COFFEE GROUNDS AND TEA GROUNDS

Abstract
The article describes quality parameters of coffee grounds and tea grounds, as main components of a potential sustainable fuel. Samples were tested to determine the calorific value, humidity content, amount of sulfur and ash produced in the subsequent process. The research has shown that biomass consisting of coffee and tea grounds may become a high-energy, sustainable solid fuel. Additionally, the possibility of producing pellets from such materials has been tested and a suitable binder, which would allow forming granules of appropriate size, has been selected.

Keywords
Pellet, Biomass, Coffee grounds, Tea grounds, Quality parameters

Introduction

The EU countries are the greatest consumers of solid sustainable fuels as the heating demand in this region is growing every year. For European manufacturers of such fuels it is obviously a good news, however high demand also results in competition growth. Therefore, desirable fuel needs to have good quality parameters, apart from competitive price. These parameters can be certified, but pellets certification is optional. Therefore, many manufacturers of solid fuels make use of only one certificate of conformity with EN 14961-2, which may be issued based on product samples delivered to the lab [1-6].

Solid sustainable fuels are usually produced in a form of granules called pellet. Pellet is a fuel material made of dried and compacted wood waste such as sawdust, woodchips and bark or energy plants [1-3]. Pellet is a kind of a good-quality briquette, having form of granules, in the shape of spheres or cylinders, in size of a few centimeters. Due to its composition, pellets have a calorific value similar to wood (15.00-19.00 MJ / kg), low humidity (<10.00 %), low sulfur content (<1.00 %), and produce a small amount of ashes (<1.00 %). These attributes make them a convenient fuel to use in the individual boilers and stoves that are equipped with reservoir, dispenser and feeder. It appears that the majority of pellets available on the market consist only of timber originating from sawmills or from energy plants that are intended for this purpose. Pellet can also be produced from straw, but such pellet produces more ashes than pellets from wood (3-5 %), which forces users to clean and service their boilers and stoves more frequently. Additionally, straw pellets require some changes in the pelleting line, for example standard matrix in pellet mill needs to be replaced by the matrix dedicated for straw. Also other types of biomass can be used dried and compacted in order to produce pellet [1-3].

The biomass can be defined as the entire organic matter that exists on Earth, all materials of plant or animal origin which are biodegradable. This includes waste or residues of biological origin from agriculture, forestry, fisheries and from other related industries, as well as cereal grains that do not meet the relevant quality requirements and other wastes from food industry [7,8].

Biomass is described by many laws and regulations, both in Polish and European law. Some legal acts define also the difference between the biomass and other waste, because biomass is often mistakenly treated as a waste. Biomass is not a waste because it is environmental friendly and it can be, for example, used for producing energy, fertilizers or can be added to animal fodder. The biomass, consisting entirely of organic material is fully degradable and does not pollute the environment [9].

Biomass has been long used for obtaining a solid sustainable fuel, often in the form of pellets, which burn well, have relatively high calorific value and low humidity content. Production of such fuels does not necessarily require any additional chemicals. Pellets are formed by drying and compressing biomass in special pelleting

lines equipped with a pellet mill (pellet press), which is a type of mill/press used to create pellet granules [10-14].
Pellet produced from biomass is an alternative fuel or so-called agropellet. There are no standards for describing quality parameters of agropellet. It is clear that such pellet will have worse quality parameters than pellet produced from wood but it turns out that it can be suitable for some energy purposes [2].

Biomass and its components are not hazardous. Biomass does not contain any harmful chemicals, it is environmental friendly, because it consists of organic matter of plant or animal origin. Furthermore, it turns out that agropellet can be a solution for eliminating most of biowaste from the environment and using it as a component for biofuels. The biowaste is: mowed grass, timber logging waste, waste from orchards (fruits and wood cutting) or fruit and vegetables farming wastes, such as peels or seeds. It also includes grass, straw, branches, peels from fruits, vegetables and mushrooms, nutshells, weeds, fallen leaves, etc. All kinds of mentioned biowaste, in accordance to the law, can be, and often is, used for producing pellet. It appears that there are various kinds of biowaste, mainly from food industry, that may be turned into high calorific heating fuel. Coffee grounds and tea grounds are good examples of biowaste that are currently treated as worthless waste that has to be disposed. However, theoretically it may be possible to use such waste to produce agropellet [10,11, 15-18].

Research part
The study material consisted of samples from:

- coffee grounds
- black tea grounds
- green tea grounds
- white tea grounds
- red tea grounds

Grounds in each sample consisted of a mixture of the same species of coffee or tea. However, a single sample could consist of products from different manufacturers. In the first stage of the study, samples were dried (for 5 hours at 105°C) in a laboratory oven. Afterwards, the quality parameters, used for describing solid fuels, were measured. The aim of the study was to determine the quality parameters of the coffee grounds and tea grounds, including calorific value, in order to confirm whether such biomass is suitable as a component for producing pellets or other form of solid biofuels.

The procedure undertaken for measuring calorific value (Lower heating value) of the fuel involves measurement of the following parameters for each tested sample:

- humidity content
- content of hydrogen
- Higher heating value

Following formula has been used to calculate the Lower heating value:

$$LHV = HHV - r*(a*h + w) \text{ [MJ/kg]}$$

LHV – Higher heating value
HHV – Lower heating value
r – heat of vaporization of water (2,455 MJ/kg)
a – hydrogen to water conversion rate 8,94
h – hydrogen content [kg]
w – humidity content [kg]

Additionally, percentage content of sulfur and percentage content of ashes left after combustion were determined.

Tests have been carried out on 3 different measuring devices:

- Calorimeter (Parr 6400 CALORIMETER) – Higher heating value
- Thermogravimetric Analyser (TGA ELTRA THERMOSEPT) – humidity, ashes
- Carbon Hydrogen Sulphur Determinator PC Controlled (ELTRA CHS 580) – sulfur, hydrogen

Tests have been carried out at room temperature (ca 25^{o}C). Each measurement was carried out in three repetitions. It was assumed that tested material has a high calorific value, but it may also have a higher content of sulfur in comparison to wood pellets and thus can produce more ash after combustion.

Table 1. Averaged quality parameters of the tested materials

No.	Tested material	Lower heating value [MJ/kg] (after drying)	Humidity [%] (after drying)	Ash content [%]	Sulfur content [%]
1.	Coffee	21.15	6.40	1.25	0.35
2.	Black tea	19.50	5.81	2.35	0.32
3.	Green tea	19.39	5.74	2.48	0.26
4.	White tea	18.20	5.67	2.32	0.28
5.	Red tea	18.76	5.63	2.34	0.10

Source: Author's

Each sample was examined 3 times and the averaged results are shown in the Table 1. Research of coffee grounds and tea grounds in terms of fuel quality parameters has clearly indicated that production of good-quality pellets from such biomass components is possible.

Calorific values of examined samples were between 18.20 and 21.15 MJ/kg (after drying). It means that all tested materials do not differ significantly from the wood pellets that are currently available on the market. In case of coffee grounds, the calorific value is even higher than that of wood pellets. As samples were pre-dried before examination, they met the humidity requirement standard for wood pellets. Drying of components is one of the steps of pellets production in pellet mills, so humidity value of examined samples should be consistent with the humidity of pellet produced from examined material.

The research showed that the tested biomass contains sulfur in amount that meets criteria of the standards for wood pellets. Besides, the presence of sulfur is a natural consequence of sulfur content in the vegetable, which are a building material of tested biomass [1,19].

The main disadvantage of tested materials compared to wood pellets is a high content of ash. The ash content in the biomass above 1% may result in faster clogging of heating boiler tubes and stoves. However, ash content at the level between 1 and 3% may not be a significant issue as long as boiler is equipped with ash handling device, i.e.; grate.

The possibility of forming pellets from coffee grounds and tea grounds was also examined. The study was conducted in a laboratory condition. Pellet granules were produced by the manual press using Parr Pellet Press. The research demonstrated that production of pellets from the dried coffee grounds and tea grounds requires usage of binder, because tested materials failed to stick together. Unlike wood pellets, tested materials contained no natural resin, which is a natural binder. Instead, starch was used. Starch is commonly used as a binder for the pellets produced from material other than timber.

Studies have shown that the addition of starch in the amount of 0.1% allows material binding and forming granules of pellet from coffee grounds and tea grounds. It follows that, in order to produce one ton of such pellets, an addition of 1 kg of starch is required. In pelleting lines, starch is mixed with biomass material, and then the mixture is pressed and heated, which results in forming of pellets.

Granules of pellets, produced by the manual press from coffee grounds (Figure 1) and from black tea grounds (Figure 2), with addition of starch as a binder, are shown in the pictures below.

Fig. 1. Pellets made of coffee grounds with addition of starch as a binder
Source: Author's

Fig. 2. Pellets made of black tea grounds with addition of starch as a binder
Source: Author's

Of course the starch is not the only binder that could be used to produce such pellet. It is possible to use other natural binders such as various types of resins or vegetable oils.

Summary

The tested material derived from coffee grounds and tea grounds has similar quality parameters to wood pellets available on the energy market. Regarding their calorific value and humidity they are equal to wood pellets, while ash content is slightly higher than that in branded wood pellets available on the market.

The necessity of using additional binder which helps to form a pellet from coffee and tea grounds may be troublesome. However, it is possible to use natural binders such as resin or starch proposed in this study. Natural binders are not harmful to the environment, therefore pellet from coffee grounds and tea grounds can still be considered as a sustainable pellet.

Moreover, such biomass can be used for producing composite pellets. In other words, various types of mixtures can be created. Coffee and tea grounds can be combined in suitable proportions with other components, such

as wood or coal dust, which should result in creation of a good quality pellet. Choosing relevant ingredients and mixing them in adequate proportions allow adjustment of calorific value and humidity content, as well as of ash.

Perhaps such pellet could be used for energy production in the nearest future to solve the problem of organic waste disposal from cafes or restaurants and to contribute to the field of sustainable energy [16,20-23].

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Ewa Kochańska
Research and Innovation Center Pro-Akademia
9/11 Innowacyjna St., 95-050 Konstantynów Łódzki, ewa.kochanska@proakademia.eu

LANGUAGE OF BENEFITS FOR DIGITAL SHARING OF KNOWLEDGE ON THE OPEN ACCESS INTERACTIVE PLATFORM

Abstract
The main objective of creating the open access to databases is to develop of innovation and efficiency in all aspects of socio-economic development. The article discusses the issue of open access to public data and focuses attention on the information of the results of research, useful to entrepreneurs. Open access to the data of the R&D institutions can be practically achieved thanks to implementation of an interactive platform. The proposed platform should uses the procedure for:

- collecting data from individual R&D institutions websites,
- translating them into language of benefits, comprehensible to entrepreneurs,
- distributing the transformed information to the proper entrepreneurs, selected by the code of NACE.

The Author tackles the topic of digital knowledge-sharing in the context of the acceleration of socio-economic development in Europe. She discusses her own proprietary software tool - an interactive platform that uses so called "the language of benefits" for transferring the scientific research results to business practice.

Key words
Open access, open innovation, bigdata management, interactive platform

Tools and procedures of digital sharing of the European science resources – state of the art.

New technologies, the key to building a competitive economy at national and regional level are arising more frequently thanks to the intimate association of enterprises with science and its latest developments. The fastest growing innovative economies nowadays base not on natural resources or other material factors as it was in the nineteenth or twentieth century, but on high-quality social capital, information and communication technologies, international cooperation on global and local scales. The crucial for the social-economic development is implementation into economic practice the innovative products and services, resulting from the common work of scientific research institutes, universities, development centers and business. The key factor determining the exchange of information between the business sector and academia is open access to data, in accordance with the paradigm of Open Data and Open Innovation Ideas.

The practice of open access to data is at a very preliminary stage of development. However, the issue of open access to information in general is analyzed by a few researchers from as countries as India [1], US, [2] and Australia [3].

An interesting presentation regarding the open access to knowledge and information, titled "Scholarly Literature and Digital Library Initiatives. The South Asian Scenario" was published by UNESCO [4]. In Europe, The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities is one of the milestones of the European Open Access movement [5]. The Berlin Declaration is in accordance with the spirit of the Declaration of the Budapest Open Access Initiative [6]. Together, Budapest and Berlin Open Access Initiatives stress that every institution of higher education and scientific institutions should have an active policy assuring that future theses, dissertations or results of the research and development are deposited upon acceptance in the institution's Open Access repository. At the request of researchers or students who seek a patent on a patentable discovery, policies should grant reasonable delays of Open Access rather than permanent exemptions. Additionally, every research funding agency, public or private, should have a policy assuring that peer-reviewed versions of all future scholarly articles reporting funded research are deposited in a suitable repository and made Open Access as soon as practicable. The important problem of management of bigdata and open access to information is analyzed by Ireland authors. They state that we have worldwide a growing number of large collections of digital sources, but we – researchers and end users - are working with them in a manner known from the analogue world. There is a need to work together - scientists and developers to

develop useful, proper digital tools in the actual research work, which can fit the open access to knowledge paradigm [7].

In Poland the Open Access issues are the subject of research studies The Centre for Open Science (CEON) dealing within the framework of the Interdisciplinary Centre for Mathematical and Computational Modelling, University of Warsaw. Polish scientist dealing with the open access to information in scope of legislation dimension is Siewicz [8].

According to the Open Data Barometer [9] the first major undertaking in terms of open access to public information (Open Government Date OGD) took place in 2008 and since then around the world arose hundreds of open data access platforms created by national and local governments, international institutions , non-governmental organizations and companies.

After all, now just only 7% of global databases is made available without restrictions, equipped by legible form and open licenses. Closed access to public data causes unnecessary inconvenience to users of the data, however the society is the natural owners of the data for example the public health service patients. The essential groups of users of public data are scientists and entrepreneurs, especially start-ups and innovators and innovativeness companies. That means the main objective of creating the open access to databases is to develop of innovation and efficiency in all aspects of socio-economic development. To achieve this, OGD should have a high level of broad political support, and their owners should invest in building collaboration of businesses and various groups of stakeholders focused on the open databases. The issue of highest importance is understanding that the OGD can be used for economic and social development.

The wish of co-founder and one of the pioneers of web technology, the British physicist and programmer Sir Timothy Berners-Lee, should be the open access to web services and to public data. Open access is one of the fundamental human rights. The right to get information and to be fully informed should be treated as the entitled public good. The fundamental conditions for the development of open access to information are:

- Firstly: acceptance for the assumption that open access to public information as a fundamental human right;
- Secondly: guarantee the security of data (date cybersecurity and Data Protection Law);
- Thirdly: developed data management systems and digitization of public information.

Experts expect that open access to data will have a positive impact the following aspects of social and economic life:

- The efficiency of the administration services, both: through more efficient internal management and providing public services of better quality and by creating opportunities for society by offering full range of data;
- Transparency and accountability of public authorities, health services, courts, etc.;
- Improving environmental conditions and improvement measures for environmental conservation;
- Activation and inclusion of marginalized groups;
- Stimulating innovation and economic growth, thanks to the possibility of wider open access to diverse information and remote contact with the administration;
- Development of world science.

The most advanced systems for open access to public information are installed now in such areas of data as statistical reports, censuses, court registers, data cadastral or vehicles registers. However, in most countries, the key data sets for business or science are not available in open access databases, and if even some of public data have been already available, but most of them is published in non-standardized formats. For example, databases of public transport, although they are based on standard, well documented data, only in 25% of countries included in the Report [9,p. 7] for the year 2013, are available in machine-readable format. Additionally, the data mapping is often not available in digital form or if it is available, then only for a fee. That means the use of public data remains a problem in many countries.

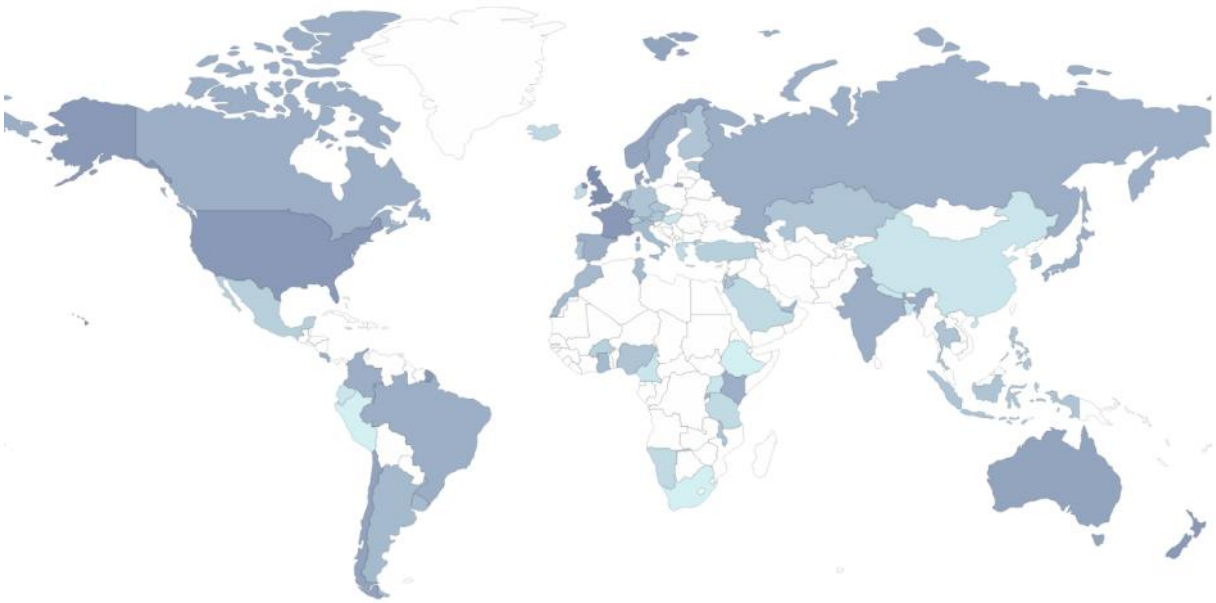

Fig. 1: Map of the level of development of OGD initiatives. Countries where OGD initiatives are the most advanced marked the darkest shade of blue, and white spots indicate a lack of data.
Source: Author's

The OGD report for 2013 year shows that areas with the highest number and the highest level of the development of open access to public data are the United States and Europe. United Kingdom is the leader among the European countries. The close relationship between the Human Development Index (HDI) and open access to public data is observed:

Table 1: The relationship between HDI and other parameters of socio-economic development (z-score)

Level of HDI	**Rights to information**	**OGD initative development**	**Civic society development**	**Government suport to OGD**	**Development of OGD in the regions or cities**
Very high	57,81	59,69	60,31	40,28	45,14
High	48,75	43,13	31,88	18,06	22,22
Medium	40,00	40,91	34,55	18,18	12,12
Low	41,11	21,67	25,00	11,73	2,47
Total	**49,48**	**44,68**	**42,47**	**25,83**	**25,69**

Source: [9]

Open data access to resources of Polish science.
In 2015, the Ministry of Science and Higher Education approved for implementation of the document titled *Trends in development of open access to scientific content in Poland, 2015* [10]. Open access to scientific information in Poland is a consequence of the adopted general principles applicable in Horizon 2020, which means a mandatory open access to scientific publications that would be created during the implementation of projects, financed under H2020.

The Polish Ministry states that the purpose of dissemination of the paradigm of open access to scientific information and data is to increase the scientific research availability for the different groups of stakeholders and foreign partners as well.

The comprehensive use of scientific research results, achieved by Polish scientific institutions, especially these which are financed from public funds, could lead not only to arising the potential of Polish science, but to support the achievements of social development economy of the country. It is recommended in the document the scientific institutions and universities to prepare and implement in practice the open access procedures

regarding publications and research data. In accordance to these above guidelines, Polish scientists, authors of scientific publications should publish their studies in a particular open repository the full content of their work, or links which take the readers to the full text. However, there is no precise information about what kind of the open repository is about - it could be presumed that the document refers to the repositories at the national level, in such a format that allows integration with the EU repositories and at the same time, the national repository should be joined with repositories of the Polish universities based i.e. on academic libraries. The Polish instrument forcing a changes towards the open access to scientific publications will be implemented now, modified system of financing magazine, published by Polish scientific institutions. The following criteria will be decided of the level of public funding for scientific journals:

- the share of foreign reviewers in the evaluation of articles;
- participation of foreign scientists in the scientific board of the journal;
- edition in English-language;
- the digitization of articles or scientific monographs and open access to them via the Internet.

The open access to scientific data may be performed in one of two forms: a gratis and a libre. “A gratis open access” means that data is available on the Internet without technical protection. The user can take it for free, but only in compliance with copyright: the user can quote with a reference, but he cannot distribute the original version or translation work. In the case of libre type access, the author of the article grants the reader a license to use his article in a very wide range. User rights model, in the libre access is comparable with the rights of an author. Detailed rules for publishing open access to information in the libre model were discussed in detail by Siewicz in the material titled Parallel publishing in open access [11]. Development of the Polish system of open access to scientific data will require in-depth analyzes in context of storage, processing, distribution and sharing of scientific information, taking into account differences between areas of knowledge, sciences and disciplines, as well as the development and implementation of the package of cybersecurity in relation to personal data. The problem of the highest importance is ensuring secrecy of data belonged to universities but to business as well, guaranteeing protection of trade secrets and intellectual property rights.

INFO-INNO-LODZ - Evaluation of opportunities to increase the effectiveness of methods of informing about the competence and resources of regional research institutes .

Open data access is a prerequisite for the development of open innovation paradigm [12]. Research and Innovation Centre Pro-Academia (RIC) a non-governmental, one of the most important stakeholder of regional innovation system in Lodz region and the scientific institution as well, has just conducted the research titled *INFO-INNO-LODZ - Evaluation of opportunities to increase the effectiveness of methods of informing about the competence and resources of regional research institutes.* The study, conducted in the period December 2014 - September 2015 consisted of the following four measures:

- A qualitative research based on a group of 56 research institutions located in Lodz region and subjected to parametric evaluation by the Ministry of Science and Higher Education in 2013, using “mystery client” methodology, modified to “mystery e-mail” research methodology.
- The study desk research with the analysis of the benchmarking of regional research institutions.
- Desk research of open access to information system about intellectual and material potential of universities, R&D institutions and scientific journals, published in Lodz region.
- The quantitative research and qualitative analysis carried out by a team of CBI Pro-Academy on a group of 1,000 respondents.

Within the research the following problems were analyzed:

- assessment of the websites of scientific research institutions as a basic tool for communication with the stakeholders, especially with entrepreneurs;
- assessment of the availability of scientific journals published in Lodz region by scientific institutions and universities for individual inventors or innovators especially entrepreneurs and start-up’s;
- assessment of the Pol-one Database as the most complex information base on intellectual and material resources of universities and scientific institutions;
- evaluation of the currently existing digitized database of scientific institutions on the regional level in order to establish cooperation with enterprises;
- SWOT analysis of existing currently methods of information about innovation in the Lodz region;
- the public opinion poll about the effectiveness of open access to information about innovations in the region.

The conclusions of the research show the need for undertaking the intensive, comprehensive efforts to build an effective system of exchange of information on research and development regional resources. Survey respondents assessed the methods used until now to inform about the innovations in Lodz region as "requiring the development" (64% of respondents), 18% of respondents considered it suitable and sufficient. These opinions have been verified by set of deepening questions. Respondents questioned about their knowledge on regards the websites dedicated innovation issues, predominantly (71% of respondents) answered "No, I am not familiar with such websites", only 17% answered positively.

To the question: "How well are you oriented in respect of Lodz region potential of scientific research?" the majority of respondents replied that they are familiar with the intellectual resources the least, they know very little about the financial resources at the disposal of universities and scientific institutes and equally little respondents know about the organizational and technical resources, or laboratories equipment.

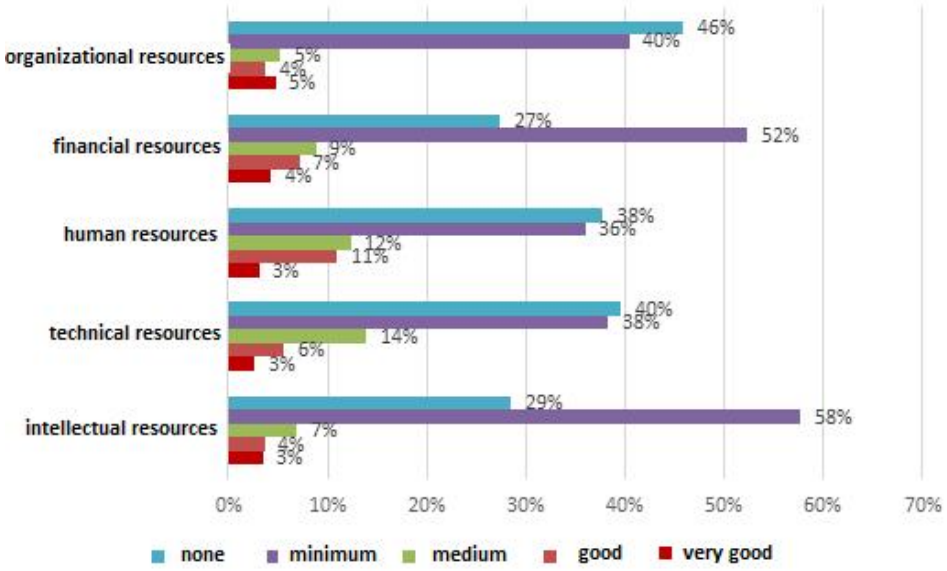

Fig. 2: The level of respondents familiarity with the regional R&D resources (n=715%). Please note: respondents could multiple choice, therefore the number of responses did not add up to 100%
Source: RIC Pro-Akademia, based on CAWI / CATI research.

During the second stage of the research the opinion of respondents about the methods and types of media were analyzed. The main aim of the research was to find the answer what form of information about innovation seemed to be the most effective as carriers of data.

The first question was: "How important for socio-economic regional development is open access to information on innovation?". 75% of respondents felt that is very important (45%) and important (30%). 15% of respondents answered it is not important, and 14% of the group said it does not matter. All respondents participating in the IDI/TIDI research expressed the opinion that the currently applied methods of sharing information, access to data about the science and form of reports on innovation are insufficient. Representatives of science stressed the need to integrate the regional potential of R&D and implement an open access to their polarized, distributed database.

It is worth to discuss about establishing the single open access platform enabling to present an offer of scientific research and repositories of science. They expressed confidence that this task should be carried out at the level of regional or national policy. They indicated the importance of collaboration of schools on all levels – starting from secondary schools, through universities, technical universities, colleges and vocational schools finishing on professional trainings for employees and unemployed people. The open access will be the effective tool for the dissemination of knowledge in the field of innovation as well.

On the other hand, young scientists, taking part in the research, showed the problem of insufficient system of information exchange not only between science and business, but also between different departments of the

university. They pointed the urgent need to integrate information databases of all research departments on the regional level but using the EU standards. This weakness of data exchange system limits the potential of creation the interdisciplinary projects. Internet was recognized as the most effective medium for dissemination of information about the resources of science. The open access internet platforms were considered as the most proper and expected tools for all sorts of promoting innovation campaigns. Within the research the analysis of the informational value of scientific publications, published by the R&D institutions in Lodz region was performed and the review of regional journals available on their websites was realized.

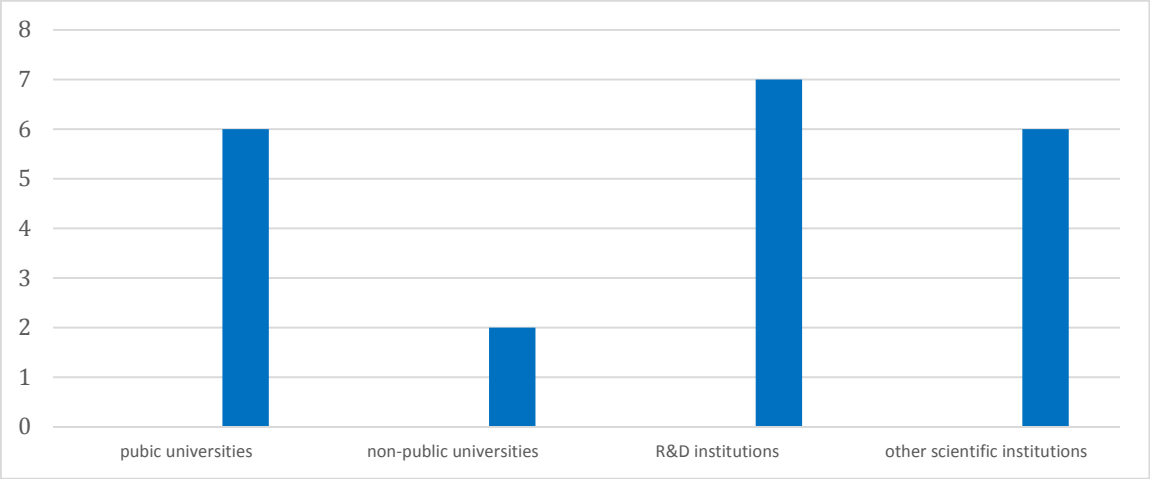

Fig. 3: Structure of scientific entities in Lodz region, 2015
Source: RIC Pro-Akademia, based on Pol-on database

Having a prestigious, high-scoring scientific journal strengthens the image of the R&D institution in the circle of scientific and proves the high quality of the ongoing research and studies and their importance for the development of science. In the current process of evaluation of scientific journals within the RIC Pro-Akademia research, the open access to journal was taken into account as the main criterion for the assessment. Contrary, for the Polish Ministry of Higher Education the most important measures for evaluation of scientific journals are: the list of reviewers, the process of review, electronic versions of articles /digitalization/. The Ministry does not assess the open access to different types of stakeholders. However now, in the *Strategy for the development of open access to scientific content in Poland* the journals are instructed to implement the obligation of digitization of all kind of publications - articles, monographs and MSc. or Ph.D. dissertations to ensure open access via the Internet to them.

How important for business is the open access to knowledge published within the scientific journals Table 2 shows:

Table 2: The evaluation criteria of open access to scientific publications from a business perspective

no.	Criterion I: Form
1	**Availability of the journal website** Is it easy to find a journal website? Is the website can be easily found through Google search? Has the journal an own active website?
2	**Clearness of the website** Is the website coherent from the form and graphic presentation point of view? Is the website readable? Does the website possess the right address, referring to the content, intuitive, easy to remember?
3	**The attractiveness of the website** Is the layout is modern, color consistent? Does it contain multimedia elements attention-grabbing, non-dispersible, but affecting favorably the reception? Does it present the additional information, attracting attention of the recipient, eg. information about conferences, events, others surprising news, attractive for readers of the website?

	Criterion II: Content
4	**Timeliness of information** Is the information presented on the website current? Can one easily find the latest edition of the journal?
5	**Completeness of information** Does the website present closed, comprehensive description of the journal, after which the reader can easily answer the question, what is the subject of the journal, to whom it is addressed? Does the website instruct the readers how they can read the articles of the journal? Does the website inform about the character of the journal - is it an academic title, what is the level of IF of the journal?
6	**Communicativeness of the website** Is website written in clear, understandable, communicative, popular style, accessible to recipients who are not expert in the branch of science? Is it possible to view the full article?
7	**Language versions** Does the site have Polish and English versions as minimum?
8	**Utility** Is it easy to reach the full content of article, download it, save it, view it at any time? Has the website the open access to archival edition of the journal? Is it possible to download graphic elements, such as logos or cover?
9	**Contact information** Does the website is full of contact to the editor - postal address, e-mail, telephone number? Are there are any descriptions of members of the editorial board? Is it possible to identify and verify the competence of the people working in the editorial board of the journal?

Source: RIC Pro-Akademia, 2015

The results of the RIC Pro-Akademia analysis of websites of journals published by scientific institutions in Lodz region, leads to the following conclusions:

- journal published in Lodz region are not adequately presented in the Internet: nearly all the websites of scientific journals are hidden deep in general websites of university or R&D institution which publish them;
- there is not clear, direct relation of the website of journal to the main activity of its publisher (university or R&D institution);
- some journal websites are part of the university service;
- there are identified some journals which have their own websites, dedicated only to a journal, not split with the general image of their publishers (e.g. Universities). In such cases, the layouts of journal website, often due to a different system on which the website is built, for example - when a website is based on the Open Journal System, or when an administrator of the website works externally, the journal website is differ from the actual website of the University. These differences are often in favor of the magazine, however, it is raised an impression of separation journals board and scientific institution.
- in the case of several journal websites the lack of basic information - such as the thematic profile – was identified;
- a characteristic feature of the journal websites is an ambition to adapt the content of the journal to The Ministerial assessment and requirements. Publishers ensure that the journal websites contain information such as a list of reviewers, the evaluation procedures, editorial ethics and information about the original version of the article. It is of course correct, and because of the Ministerial assessment, which is the main, essential indeed subject to publishers, but from the point of view of stakeholders outside the science – the open access to journal is the criterion of the crucial character.

Good communication with the reader outside of the scientific community should be the ambition goal for publishers of the scientific journals. Finding the balance between high level of knowledge, which ensuring a high position of the journal in the Ministerial assessment and utility and accessibility to different groups of the innovation ecosystem stakeholders is the definite challenge nowadays.

Editorial board of the journals should be aware of the needs of different groups of stakeholders, to whom they address the intellectual message - whether they are ministerial decision-makers, academics, researchers, authors and readers of scientific texts, or entrepreneurs. The analysis and result of the research lead to the general, but not very optimistic conclusion that journals published by scientific institutions in Lodz region do not notice and appreciate entrepreneurs as their readers. To change this situation and to encourage entrepreneurs to be a readers of scientific journals via journal websites, the communication strategy of journals should be re-thinking, namely:

- Firstly - a journals should carry a clear, attractive form of presentation of scientific issues in the "language of benefits";
- Secondly – the special descriptions in popular style, addressed to entrepreneurs should be added;
- Thirdly – the supplement to website with information about conferences, events should be implemented. One of excellent way to build strong relationships with readers, including entrepreneurs, may be the newsletter informing e.g. about the content of new edition of the journal, promising articles, invitation to the contact with authors or publishers;
- Fourth - it is necessary to organize open access to information and full articles, and to summary of the major collections and databases;
- The fifth - in the modern scientific communication, journal websites cannot be just a "showcase", must offer the open access to articles, and to authors, reviewers. Thanks to open access database, the coordination, internal work of editorial board, publishing and sharing innovation ideas will be easier.

The European interactive platform – the open access to data and information of science.

Analysis of information system on research, conducted in scientific institutions in Lodz region, resulting from the above-presented RIC Pro-Akademia research leads to the conclusion, that the lack of interactive and automated tools for organizing cooperation between science and economy is noticed. The existing database of science are closed, static, distributed, written in language too specialized and hermetic, inaccessible to individual scientists, e.g. Ph.D. students and mostly – the websites have been not updated. The websites of research institutes don't clearly identify information files that would be addressed to entrepreneurs specifically. On the websites of the R&D institutions, there is no invitation for collaboration for Polish companies, nor for the foreign partners. Contrary, at the moment, companies do not have the appropriate tools on websites which could be used to affect the R&D institutions in Lodz region.

These problems and conclusions of the above presented research lead to the following observations:

- lack of an integrated, comprehensive and open database of science and research affects unfavorably for the key sectors of the regional economy;
- lack of tools like "research and technology watch" which would be programmed for permanent monitoring the websites of universities and research institutes, scientific journals, conference seminars, etc. in order to gather data, share knowledge and create innovations;
- considering the tremendous pace of changes in the strategic for the EU and Poland innovations, lack of open data base in research and development is one of the major reason of low level of innovativeness in Lodz region;
- ongoing monitoring of R&D in the world, in the European Union, in Poland, but also in the region, reviewing the innovations in context their implementation into the regional economy would be extremely useful to entrepreneurs;
- the major weakness of the existing websites of the scientific institutions is their distributed character - each research center has its autonomous, closed database, with its own formatting system. The information presented there are addressed to a narrow audience: usually to students and employees of its own;
- databases and websites of R&D institutions use the hermetic, specialized language, completely incomprehensible to entrepreneurs and other stakeholders of the regional ecosystem of innovation;
- databases and websites of R&D institutions do not allow the Bi-directional transmission of information and they don't learn thanks to feedback from the readers;
- the research institutes do not define on the websites an area of potential applications, and even more, do not foresee the potential market for the research;
- websites of R&D institutions do not use the mechanisms or ICT procedures, which enable just-on-time feedback, reviewing and evaluation the R&D activities, carried out in scientific institutions.

RIC Pro-Academy is - on the one hand as a modern scientific institution, supporting business and on the other as a research institute, conducting R&D tasks in the research areas corresponding with regional smart specializations. That is why the important goal of RIC strategic goal for the 2016 year is to introduce into market the model internet platform of open access to scientific data. Model and demo of the interactive platform with the open access to data, regarding the rising of innovation will be the answer to the problems outlined above. The platform will be technologically advanced and programmatically comprehensive tool for implementing the new service supporting promotion and diffusion of open innovation paradigm in the model of open data access.

The proposed platform will meet three specific objectives:
The Objective no. I. in context of the following problems:

- Websites and databases on R&D of research intuitions in Poland are static and require the stakeholders outside the science society, especially entrepreneurs would make efforts to find and follow the information on the conducted research. This assumption is unrealistic.
- Companies do not benefit from the achievements of R&D sector because they do not know what research are conducted in scientific institutions, and traditional forms of promotion of science are inadequate and too expensive;
- Information on research and R&D activities are undeveloped, incomprehensible, did not take into account the specific needs of decision-makers in economy nor the "language benefits" and usually they come to companies too late.

The proposed inter-active platform will include a procedure of permanent monitoring the R&D achievements and sending a newsletter with information about them to enterprises according to the code of their economic activity NACE (Nomenclature of Economic Activities, the European statistical classification of economic activities). Newsletter will be distributed via platform according to the NACE which suggest that these companies can be potentially interested in implementation of the results of the research.
Of course, the newsletter should be generated in the language understandable for entrepreneurs, basing on the "language of benefits".

Objective I: Increasing access of companies to the open access data and interactive platform allowing the exchange of information and strengthen the cooperation between science and the economy, according to the paradigm of open innovation.

The Objective no. II. in context of the following problems:

- The percentage of innovative companies in Poland is very low and the Lodz region is on the last three places in Poland in this respect.
- A comprehensive system of auditing technology and evaluate the regional R&D activities in context of potential for bringing them to the market is not conducted.
- The future users of the technology, especially entrepreneurs are not engaged by R&D intuitions, not at the stage of design and creation, nor at the stage of auditing processes of commercialization.
- There is no evaluation R&D processes in relation to regional smart specialization.
- Procedures forecasting economic efficiency and competitiveness, resulting from the implementation of different types of innovation: process innovation, marketing, organizational and social innovations are little known and rarely used by companies.
- Procedures for risk assessment regarding the technology implementation are rarely implemented in the practice of enterprises.
- The benefits resulting from technology transfer and long-term business-science networking rarely take into account by both sides of the net-work.

The platform enables the development and testing the innovative ICT tools for open data access to the regional R&D sector in context of commercialization and implementation R&D results into practice in the region.

Objective II: Making stakeholders of the regional innovation ecosystem to assess the possibility of implementing innovation and R&D results into practice of enterprises, municipalities, cities and local communities on the regional level.

The Objective no. III. in context of the following problems:

- Although the annual value of Polish export of Hi-Tech products and services continuously increases, the Polish companies occupy the last place in the ranking of the European Union in terms of exports of high-tech products as share of total exports [13].
- National and regional support for the expansion of export companies with innovative products or services is limited
- There is a lack of tools for assessing the R&D potential for creating new technologies in the context of the high-technology products or services dedicated to domestic and foreign markets.
- There is no analysis of the potential threats from competitors or to identify opportunities for the development of the regional economy based on knowledge.

The platform allows for the development of innovative, auditing R&D sector tools in order to use them for creating the innovative products and services, which can be offered by the regional companies on domestic, the European Single Market or on the markets outside the EU.

Objective III: Facilitating assessment of the competitiveness of innovative products or services thanks to inter-active tools offered on the platform.

The discussed interactive platform will be equipped with ICT tools, enabling tracking and watching information on R&D intuitions websites. A very important requirement, being de facto a condition of effectiveness of planned functionalities of the platform is bound administrators of R&D websites with the open data access idea. Administrators should use – firstly - key words, identifiable by the navigation system platforms, such as "applied research", "development", "Innovation", etc., and secondly - to join information about research with the proper areas of implementation into business, assigned the research with the NACE code. The principle advantage of interactivity platform is linking the results of the research with the NACE of business activities. There is the open database of existing companies in the European regions. One can without any difficulties segregated companies database according to the criterion of NACE and adjust them to appropriate research, and finally send to selected companies a newsletter with information about ongoing R&D.

An important component of the interactive platform is an innovative tool for managing database semantics, according to the needs and level of specialization recipients of newsletters. Management information base semantics means paying attention to joining together the word, form, image and the actual content having in mind the readers of information. Semantics as a branch of science investigates whether the construction of the word determines its meaning and whether the relationship between linguistic expressions and objects to which they relate help in understanding the content that they carry.

The platform should base on synchronized relational database. Relational Database (RDB) consisting of multiple files and databases, which may cooperate with each other, have internal programming languages (SQL) by which it is possible to design the handler and data conversion. Designing the database one should take care of aspects of concurrency control and throughput. These aspects, due to their vastness and complexity, will constitute important factors determining the speed of the whole platform.

The proposed open access solution will be based on the new intelligent, semantic concept that not only enables to search for keywords, but also intelligently to assemble and to translate the contents of platforms delivered by R&D institutions, into the “language of benefits”, according to the possibilities and needs of entrepreneurs. As the platform manages the programmed transmission of data and information from scientific institutions to entrepreneurs, it should have an "interpreter" of specialized, scientific, hermetic language into the popular nearly every-day language. Like many well-known translators / dictionaries of foreign languages, for example https://translate.google.com/#en/pl.

On the platform are scheduled tools to manage databases, which are to control the relationship between data and semantic meta data. Thanks to this approach, the automatic translation of documents, delivered by the R&D institutions will be possible. Describing the proposed project platform, it is worth pointing that there are a few solutions of the semantic web search engine, which bases on two exploration methodologies: the first one: the solution is analyzing currently accessible websites or data bases or the second methodology: the solution creates its own the semantic search engine, which is scanning networks, websites, databases and is using the original semantic algorithms for automatic transcription.

The development of the interactive platform will be determined by the position of scientific institutions so to open access to their database and semantic descriptions of their information. As examples of the existing search engines, useful for the open access to scientific database are Swoogle, Sindica and Powerset. Another important solution, consistent with the planned platform is the automatic watch-dog of selected databases and then, through the procedures of intelligent algorithms, semantic stream of input data will be converted into information expected by the end user in "language of benefits". Currently used, distributed databases, conducted by scientific institutions will be subject to the integration processes. Many different narrowly specialized databases are united into a single virtual BigDataBase in a transparent and unnoticeable to the user manner, who feels that uses one large information platform. Key challenges for handling BigDataBase Management System, which allows the use of information resources from various sources, written in different ways, at different times, etc. are unification and cybersecurity problems resolving. Inconsistencies between different data sources are the results of not only the data schemas, but the semantics, i.e. data on different websites, despite of the same meaning of data, may be presented differently because of the different approaches to scientific observation description of the same phenomena. BigDataBase Management System developed an interactive platform should take into account the following differences, observed on the R&D websites:

- First: the type of data;
- Second: the values and standard of measurement of data;
- Third: semantics, language and meanings of data;
- Fourth: the values of abandoned and missed data.

The platform, using the database of the individual research institutions will respect their autonomy and heterogeneity, local priorities, rules of ownership, rules of authorizations of access and of cybersecurity. Procedures for integration and requests for information must therefore be correctly identified and properly addressed. Only then the platform will be the useful and appropriate link between local, European and world R&D databases and stakeholders outside the academic environment expectations.

Conclusions

Open access to data, particularly to information creating by the research and development institutions that may be useful for business is on the very beginning state of development. Problems that affect the establishment of open access databases are of the varied and diverse nature: technical, social, economic specific should be taken into consideration. The most advanced initiatives of the open government data /OGD/ are curranty accessible in countries with a high HDI, where human rights are fully respected - the right to information is one of the fundamental human rights.

Polish science is facing actually a huge challenge, requiring not only digitization of their intellectual resources, but also to make them available in the form of open access databases.

The research *INFO-INNO-LODZ - Evaluation of opportunities to increase the effectiveness of methods of informing about the competence and resources of regional research institutes*, conducted by the Research and Innovation Center Pro-Akademia has just identified the main problem areas that should be taken into account in the process of establishing the open access to knowledge. The answer to the problems have been diagnosed is recommended in the last part of the article – an interactive platform.

The platform, using the database of the individual research institutions will respect their autonomy and heterogeneity, local priorities, rules of ownership, rules of authorizations of access and of cybersecurity. Procedures for integration and requests for information must therefore be correctly identified and properly addressed. Only then the platform will be the useful and appropriate link between local, European and world R&D databases and stakeholders outside the academic environment expectations.

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Grzegorz Szymański
Lodz University of Technology, Faculty of Organization and Management
ul. Piotrkowska 266, 90-924 Łódź, grzegorz.szymanski@p.lodz.pl

THE INFLUENCE OF CONSUMERS' FEATURES ON THE POPULARITY OF INDUSTRIES IN THE E-COMMERCE SECTOR

Abstract
The main objective of the study is to identify the forms of shopping among the Polish Internet users. The results of a survey conducted on the sample of over 13,000 respondents were analysed. Despite the dynamic development of the m-commerce sector, almost 90% of those polled use a traditional personal computer for online shopping. While analysing the results in terms of gender and the category of assortment, it was concluded that there are significant statistical differences. Men are more likely to buy in online shops, particularly large disparity was noticed in the pharmaceutical industry and the electronics and household appliances industry. While analysing the impact of the category of assortment on purchasing channel, differences exist in the area of tools, sport and pharmaceuticals where the products are more often purchased in conventional stores than in their online counterparts.

Keywords
E-commerce, e-consumers, Internet users, e-shops, purchasing channel.

Introduction

The number of Internet users in Poland is permanently increasing, the vast majority of Y generation use the Internet at least once a week, while the youngest generation (born after 2000) consider the Internet to be a part of their normal life [1]. Shopping online should be something natural and ordinary for Internet users and the main barriers of the development of e-commerce such as security of transactions, time and cost of delivery are regarded as a standard and truism.

The aim of the study is to identify the form of online shopping. In the process of operationalisation of research the following questions were asked: What is the ratio of the number of Internet users who shop online to the number of Internet users who shop on the traditional market? The following hypothesis were also specified: H1: Internet users much more often buy in e-commerce sector than in traditional stores and H2: a computer is the most popular tool used during online shopping.

The most important point for satisfying e-consumers' expectations and needs is their online behavior analysis, which aims to growth of profits of e-commerce market. Also it aims to identify the different online behavior of internauts (divided into men and women), especially used device, attitude, behavior and satisfaction. Online shops increasingly adapt the structure of the online service, products and advertising in order to perform detailed customer segmentation [2]. Analysis of the impact of the characteristics of clients on their behavior were analyzed from the beginning of e-commerce [3]. The behavior of individual customers do not only depend on gender or age, but also on many personal characteristics. You can highlight consumer decision-making dimensions: perfectionism, brand consciousness, Novelty-fashion consciousness, Recreational shopping consciousness, price-value consciousness, impulsiveness, carelessness, confused by overchoice and brand-loyal [4].

E-commerce

The Internet has become a catalyst for global changes and modern economy. Nowadays e-commerce is undergoing a phase of a dynamic development. The number of Internet users and buyers through the medium of the Internet is increasing permanently. Trading companies, which want to be competitive on the market, must meet the demands of the society and follow created trends. E-commerce business activity does not only refrain to electronic trading platforms but also includes activity in other related areas: banking [5], distribution and e-marketing. An escalation of e-commerce and the increase of the competitiveness of this sector shape pro-consumer and innovative attitudes among entrepreneurs whose job it is to follow the expectations of

customers and stand out among the competitors' offers. The effects of such attitudes are the following concepts: online group buying [6], crowdfunding and crowdsourcing [7] and innovative forms of advertising: prankvertising, viral and guerrilla marketing [8].

One of the most general definition characterises e-commerce as a process of buying and selling supported by electronic devices [9]. A similar description can be found in other studies [10], [11]. Whereas more detailed definition specifies the concept of e-commerce as an electronic platform for conducting a business activity on which contacts between participants of economic processes take place, transactions are being made and values are created and exchanged [12].

Modern e-commerce can be divided into even more specific forms: m-commerce, s-commerce and TV-commerce, where m-commerce is defined as trading via mobile devices with special emphasis on smartphones and tablets. While the f-commerce form is linked to the conduction of a trading activity using Facebook, which can be widely seen under the concept of social commerce (s-commerce). The basic division of e-commerce is classified in two ways today: the m-commerce and trading with the use of desktops or laptops. Whereas the TV-commerce seems to be the least popular form of e-commerce, sale of products using the medium of television faces a lot of constraints. However, the facts speak in favour: more than 90 million of annual revenue of the company Mango24, the increase in the number of television sets with an access to web applications, technological progress allowing to control the TV with voice or hand movements. Although e-commerce is a broader concept of Internet commerce (and i-commerce) by definition, due to the massive participation of the internet medium the terms: e-commerce, online and virtual commerce shall be applied interchangeably for the need of this study, considering them identical and referring only to the aspect of the actions using the Internet as a channel for transactions and communication.

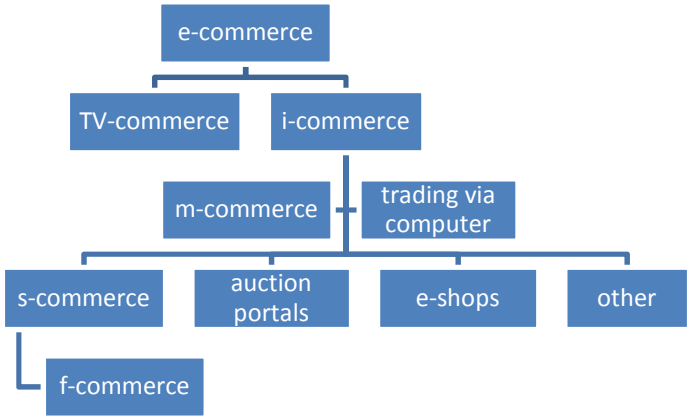

Fig. 1. The interdependence of the various e-commerce forms
Source: own study.

The Polish e-commerce is still growing rapidly according to the CSO report 'in 2014 34% of people stated that they ordered various goods in this way, mostly clothing and sports equipment, within the period of 12 months preceding the start of the study' [13]. Whereas the Gemius says that 55% of Internet users shop online, these are mostly people aged 25-34 years old (34%). The results of the relationship between the used equipment and the popularity of e-shopping are puzzling because they indicate that each of the analysed groups shop online (laptop - 98%, PC - 99%, tablet - 99% and smartphone - 97%) [14]. These results differ significantly from the data from other reports where the differences are substantial [15], especially in Asian countries where smart phones have been leaders of e-commerce market for several years [16].

An e-consumer is the most active consumer who, on the one hand, obtains information from various sources in the purchasing process, and, on the other, actively comments and transmits information about the company and purchased products [17]. A consumer on the electronics market is willing to use the opportunity to interact with a bidder, this activity also constitutes an important factor while making purchasing decisions [18]. Customers' concerns including fraud, the lack of the possibility to address a complaint and a doubt that the purchased product is not in compliance with the offer are among the biggest barriers to escalate the development of e-commerce in Poland [19]. However, generalizing the obtained results of the overall group of

e-consumers may have a negative impact on the reliability of the analysis because the age of e-consumer is a very important determinant.

The most popular division of the society into generations which appears in the contemporary organizations has 5 generations: Mature (born between 1930-1945), Baby Boomers (1946-1960), X Generation, also called Baby Busters (1961-1982), Y Generation known as: Millennials, WWW Generation, Digital Generation, Google Generation (1983-1999) and Z Generation (born after 2000) [20, 21]. The most active customers in the e-commerce sector is Y Generation, whose representatives have the ability to work, willingness to share knowledge, are ambitious and open to changes, know the advantages and risks of the Internet [22]. Although Z Generation is a generation of people growing up among the ubiquitous Internet communication, their contemporary smaller relevance for e-commerce sector is a result of the lack of financial independence. However, their behaviour and needs should be important determinants of creating future strategies of companies.

E-customer in the e-commerce

In order to achieve the goal, the raw data received from the Opiniac company, as part of the scientific cooperation, was analysed and used to prepare the 'ROPO Effect in the Polish E-commerce Segments - 2015' report [23]. The study was conducted on a group of 13778 Polish Internet users at the end of May and the beginning of June 2015. 66% were women, indicating an asymmetrical test, and therefore individual results are recognized in relation to the total number of women or men. A total of 14932 responses were obtained because each respondent could answer the same questions in several assortment categories. Purposeful, convenient selection procedure of the sample was used, distributing a questionnaire on the popular information portal (Onet.pl) and a number of industry portals. The confidence level of 0.99 and the error of estimate of 0.011 were obtained for the population of Internet users in Poland at 35% (approx. 12 250 000).

Table 1 shows the results of the popularity of Internet devices used while shopping online. The results strongly suggest that computer is currently the most popular tool among e-customers. Although m-commerce is growing rapidly in Poland, tablet and smartphone achieved results at the level of 5% of the share in the survey.

Table 1. Device preference among Internet users when shopping online

used device	**number of responses**	***%***
computer	13224	88.56%
tablet	740	4.95%
smartphone	797	5.34%
I don't remember	171	1.15%

Source: own study based on raw data provided by the Opiniac company used for the 'ROPO Effect in the Polish E-commerce Segments - 2015' report.

An observation of the general results of the answer to the question 'Have you recently made a purchase in a traditional shop or online?' was that the majority of respondents (62%) indicated a traditional shop. The term "recently" was identified as the period of the last 3 months. Whereas the important issue of this question was to identify the clients of the industry of market. When making a statistical analysis in the form of Chi-square test for the dependent variable as gender in relation to the category of product range (Table 2), the value was 766.25 and $p < 0.000001$ which proves the existence of the relationship between e-customer's gender and assortment category. More women buy products from the categories: sport, books, film and music as well as medicines and cosmetics than men. While the results obtained for cosmetics and dietary supplements are not surprising, the predominance of women purchasing goods, clothes or sports shoes may seem unexpected. In order to identify the cause, an in-depth study to verify the individual parameters should be carried out.

Men more often tend to buy electronics and household appliances as well as DIY (Do It Yourself) - tools, building materials and gardening products. A lower male prevalence was found among tourist products.

Table 2. The popularity of the assortment category among the Polish Internet users divided by gender

assortment category	gender	number of responses	% in relation to the total number of polled women n=9093 or men n=4547
sport	men	2856	62.81%
	women	6177	67.93%
tourism	men	1237	27.21%
	women	2171	23.87%
DIY - tools, building materials and gardening products	men	2184	48.03%
	women	2806	30.86%
books, films, music	men	1623	35.70%
	women	3580	39.37%
medicines, dietary supplements, cosmetics	men	2107	46.34%
	women	6475	71.20%
electronics, household appliances	men	2874	63.21%
	women	4099	45.08%

Source: own study based on raw data provided by the Opiniac company used for the 'ROPO Effect in the Polish E-commerce Segments - 2015' report.

While analysing the impact of forms of purchase (traditional or electronic shop) on the assortment category, it is also possible to affect the existing dependencies, the value of statistical test Chi-square was 2743, while the level of $p < 0.000001$, Table 3.

Table 3. The popularity of forms of purchasing and assortment category among the Polish Internet users divided by gender

assortment category	gender	Form of purchase	Number of responses	%
sport	men	electronic	1000	35.0%
		traditional	1856	65.0%
	women	electronic	2279	36.9%
		traditional	3898	63.1%
trips and holidays	men	electronic	682	55.1%
		traditional	555	44.9%
	women	electronic	1095	50.4%
		traditional	1076	49.6%
tools, building materials and gardening products	men	electronic	418	19.1%
		traditional	1766	80.9%
	women	electronic	408	14.5%
		traditional	2398	85.5%
books, films, music	men	electronic	896	55.2%
		traditional	727	44.8%
	women	electronic	1934	54.0%
		traditional	1646	46.0%
medicines, dietary supplements, cosmetics	men	electronic	675	32.0%
		traditional	1432	68.0%
	women	electronic	1655	25.6%
		traditional	4820	74.4%
electronics, household appliances	men	electronic	1579	54.9%
		traditional	1295	45.1%
	women	electronic	1876	45.8%
		traditional	2223	54.2%

Source: own study based on raw data provided by the Opiniac company used for the 'ROPO Effect in the Polish E-commerce Segments - 2015' report.

The general results obtained show that both women and men are more likely to make purchases in traditional shops in the analysed sectors, the answer was given by 59.2% of male respondents and 63.5% of female respondents respectively. The only category, that shows important differences, is the electronics and household appliances, in which almost 55% of men and only 45% of women use an electronic channel. However, in the pharmaceutical industry both sexes prefer the traditional channel but the percentage of women is higher because it makes up 74%, with 68% share among men. Five percentage points difference was also recorded in a group of DIY products, almost 86% of female respondents and 81% of male respondents prefer shopping in traditional shops. The categories of sport and books, music and film does not show the diversity as far as the e-client's gender is concerned in terms of the selection of a shopping channel. Products from some industries (trips and holidays, electronics, household appliances), are purchased more frequently in e-shops. The reason is the lower price and no need to check the quality of the product. In the sports industry, an important element for consumers the quality and fulfil the expectations of the products. Low popularity of online purchases of medicinal products is caused by too long delivery times and a lack of opportunities to buy prescription drugs. A wide range of forms and types of tools, building materials and gardening products means that customers very rarely decide to purchase online (only 19% men and 14% women). The proposals are subjective, because these issues have not been verified in this research. Identifying the reasons for the selection of individual forms and channels of purchase is an interesting problem that requires further studies.

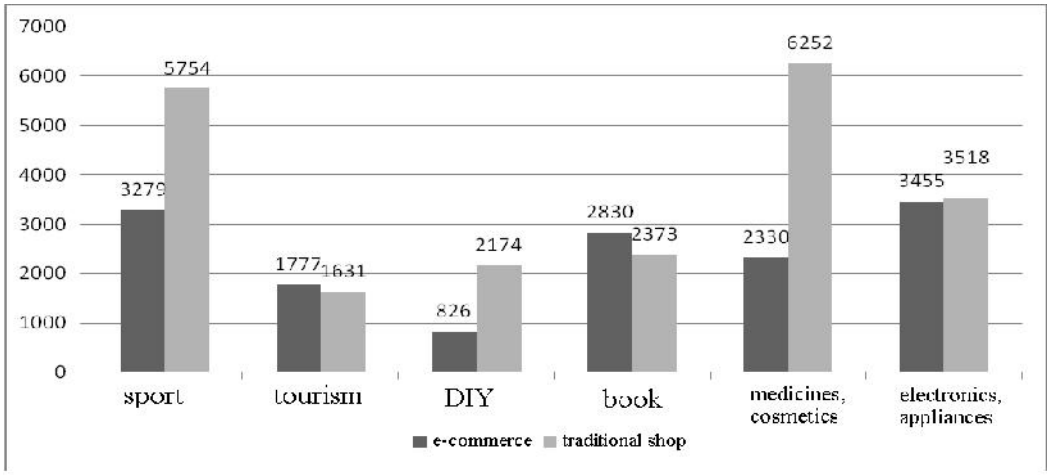

Fig. 2. The global data of the table 3 regardless of gender

Source: own study based on raw data provided by the Opiniac company used for the 'ROPO Effect in the Polish E-commerce Segments - 2015' report.

Having analysed the results of each assortment category in the classification based on shopping channels, it was concluded that the biggest differences are present in the category called medicines, dietary supplements and cosmetics, where three-quarters of women and more than two-thirds of men opt for the traditional sales channel. This is probably due to the law provisions that prohibit the sale of prescription medicines by electronic means and the greater need to get the pharmaceutical product immediately. Another assortment category, whose products are often purchased on the traditional market is the sports and DIY industry, or 'do it yourself'. Tools, building materials and gardening articles are products whose appearance and functioning customers want to know organoleptically before making a purchase. Just like clothing and sports equipment. The only categories, among which there was a little advantage of online shopping, are tourism and books, music and film. Products from these industries do not require prior knowledge of the properties or, as in the case of tourism, the offer presented in the office and on the website is very often just as valuable to a potential customer.

It is worth noting that many cases were reported in the study where single respondents bought product from some categories on the electronic market and from other categories in the traditional form. These examples can confirm the existence of a relationship between the choice of a purchasing channel and an assortment category of the purchased products.

Summary and conclusions

The development of e-commerce in Poland is still in the growth phase. The increasing number of Internet users and e-customers are determinants that indicate a further tendency for intensification of this trend. The popularisation of m-commerce and social commerce which result from the expectations of Internet users is also significant. The main advantages of e-commerce is the lower price of the product, convenient shopping and the ability to quickly compare competing offers. These features indicate that Internet users should use the electronic form of purchases more frequently than traditional solutions. However, the analysis of the results of the survey indicates that only 38% of respondents are more likely to make purchases on the Internet, which negatively verifies the H1 hypothesis proposed in the introduction, considering an alternative version to be true: the Internet users are significantly more likely to make purchases in traditional shops than in the sector of e-commerce. Responding simultaneously to the research question, the proportion of Internet shoppers to the traditional forms of shopping is 3:5.

Both the assortment category and the e-client's gender are relevant for the popularity of the shopping channel. Results show a statistically significant difference across all industries for men and women, but the categories which achieved the greatest discrepancies based on gender are: tools, building materials and gardening articles (approx. 18 percentage points), pharmaceuticals (approx. 25 percentage points), equipment and household appliances (approx. 18 percentage points). Some popular industries were excluded from the study, for example, the food sector was omitted due to the low popularity of online shopping in Poland, while the automotive industry is growing rather on the level of exploration, verification and comparison of offers, and not on the finalisation level.

Disparities are also found in the analysis of the comparison of the assortment category due to the form of purchase. DIY, sport and pharmaceuticals are the areas where the products are more often purchased in the traditional shops. While tourist services as well as books, music and films are more often purchased in the e-commerce sector.

While analysing the results of the study it can be easily concluded that a personal computer is the most popular device for online shopping. Almost 90% of respondents use it. The result positively verifies the H2 hypothesis.
Despite the relatively large sample research, the subject of the popularity of devices and shopping channels among Internet users has not been exhausted. It would be valuable to identify the factors influencing the choice of a specific device or a channel by respondents, with particular emphasis on the assortment categories.

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