# POSSIBILITIES OF USE OF MECHANICAL SURFACE TREATMENT WASTE IN FORM OF POLYMERIC PARTICLE COMPOSITE FILLERS

**Petr Valasek, Miroslav Muller**
Czech University of Life Sciences, Faculty of Engineering,
Department of Material Science and Manufacturing Technology
valasekp@tf.czu.cz

**Abstract.** Polymeric particle composites which synergically combine properties of filler and of a matrix are of a great potential to satisfy a number of requirements of many branches by their resulted behaviour. Using surface mechanical treatment waste as the composite filler adds also a possibility of economical non-dangerous waste material recyclation way to the resulted properties of the formed material as the form of the fortifying phase of the particle composites. The experimental specimens filler (the fortifying phase) was waste from the process of machining and blasting. Its fraction differs from common particle filler by a large dimension and heterogenity of single particles. The two-component epoxy adhesive was used as the matrix (the connected phase). The influence of various fortifying phase coming from waste and composite mechanical properties changes depending on different filler volume portion was experimentally tested at the formed polymeric particle composite. Setting the polymeric particle composites behaviour is important for a definition of their application possibilities. It is supposed to use such systems in the sphere of puttying adhesive bondings or renovation of various materials and machine particles.

**Key words:** mechanical properties, particle polymeric composite, waste.

## Introduction

Our knowledge of differing behaviour of particular materials enables us to put those to optimal use. Particle composites are materials reinforced by non-fibral particles, proportion of which does not differ significantly in any dimension. The particles are round, cubical, quadrilateral or similar to these [1]. The polymeric particle composites combine synergically properties of the matrix and mechanical properties of the filler. Particle composites' matrix can be replaced by epoxy adhesives and with appropriate filler this creates a number of beneficial properties. Particle reinforcements are used mostly for increasing the product's hardness and abrasion resistance [2]. The key characteristic of the composite materials produced as waste during the process of mechanical surface treatment is the heterogeneous size of the fortifying phase as opposed to the classical polymeric particle composites [10]. Replacing primary materials with secondary ones brings not only considerable economic benefits, but also benefits in the field of ecological waste management. The subject of the experiments conducted was a polymeric composite with a two-component epoxy adhesive as the connected phase and as the fortifying phase (the filler) we used abrasive waste showing neither signs of hazardous properties as listed in the appendix 2 nor components listed in the appendix 5 of the Waste Act 185/2001 [3]. With materials, whose connected phase is formed by the waste from mechanical surface treatment we can anticipate certain properties and their partial fluctuation based on their potential heterogenity and imbalance. Even though such behaviour of the material is highly undesirable, the importance of the experiment conducted lies mostly in potential material recycling of the mechanical surface treatment waste. These materials' proposed use will be mostly in renewal of mechanic parts and in various cementation systems, which would be liable to wear. The mechanical parts are normally in many cases exposed to shocks and for that reason the samples were analysed not only in terms of the produced materials' resistance to abrasive wear, but also having in mind their sensitivity to dynamic strain in form of impact. Clear assessment of the materials' behaviour considering these mechanical characteristics will set or rule out their possible usage [9].

## Materials and methods

As the polymeric particle composite matrix, the two-component epoxy adhesive LEPOX UNIVERSAL P11 was used. Epoxy resins are among the most versatile thermosetting polymers for use in construction, with outstanding resistance to wear and tear and very good chemical resilience and small amount of shrinkage during the hardening process. They are also known for their adhesion to metals and, provided the inorganic filler is chosen correctly, they enable us to influence considerably the range of the mechanical properties of the resulting material [4]. As the filler we used waste from the surface treatment process, in particular an abrasive from the blast cleaning of fractions F80 and F240 listed in the Waste register under 12 01 17. The polymeric particle composites were prepared with 25, 50, 75, 100 and 125 per cent of the filler. By expressing the share of the filler phase in percentage of the capacity we exclude the impact of the density difference between the matrix and the sample composite filler. In the process of preparation of the experimental objects the most emphasis was put on the homogeneity of spreading the filler in the matrix, which was achieved by using ultrasound. The samples were infused into the forms made of the Lukapren N material in such a way, that the objects are in accordance with the norm: ČSN 64 0611 (Determination of the impact resistence of rigid plastics by means of Dynstat apparatus), the hardness of the samples was measured with the Shore D method [6, 7]. When evaluating the resilience against abrasive wear, the experiments used the norm ČSN 01 5084 (Determination of metal material resistence against wear by abrasive cloth) [5]. The samples were fastened onto a special head, loaded with the pressure of 0.0916 MPa and pressed down against an abrasive cloth with P220 fineness and moved from its side towards its middle along a track the length of which had been set beforehand [8, 11]. The sample's contact with the abrasive cloth resulted in weight loss in the material.

## Results and discussion

The samples' hardness test was conducted via the Shore D method on samples sized 2.5 mm x 2.5 mm in two layers. The first 'sediment' layer was the bottom part of the sample and the second 'non-sediment' layer was the top part of the sample (see Figure 1, where *Fg* stands for the sense of the gravitation force affecting the sample).

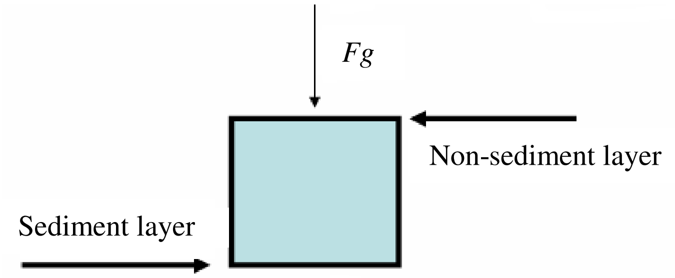


Fig. 1. **Diagram of the set of the hardness measurement**

The bottom sediment layer displayed greater hardness than the non-sediment layer. This hardness grew with the growing share of the filler in the samples' matrix. The difference in hardness of the layers was probably caused by the fillers sedimentation during the samples' hardening process. The dependence of hardness on the share of the filler and the extent of the standard deviations is shown in Fig. 1 for the sediment layer, in Figure 2 for the non-sediment layer. The measurement has proven that mechanical surface treatment waste based filler enlarges the resilience of the resulting composite. This resilience grows depending on the amount of the filler in the matrix. In the non-sediment layer, the hardness is lower than in the sediment layer. With the samples with F80 filler, the maximum hardness (Shore D) was 93.5±1.0 in the sediment layer and 91.7±1.1 in the non-sediment layer. With the samples with F240 filler, the maximum hardness (Shore D) was 93.0±0.9 in the sediment layer and 90.5±1.3 in the non-sediment layer. The hardness (Shore D) of resin without any filler (etalon) was 83.1±3.2 in the sample as a whole.

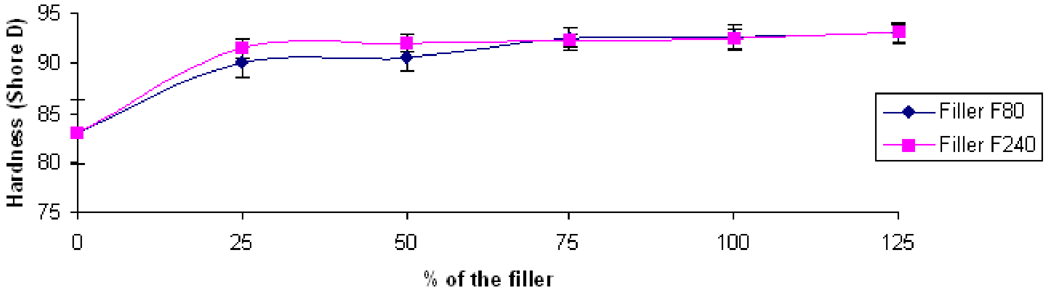


Fig. 1. **Hardness Shore D – sediment layer**

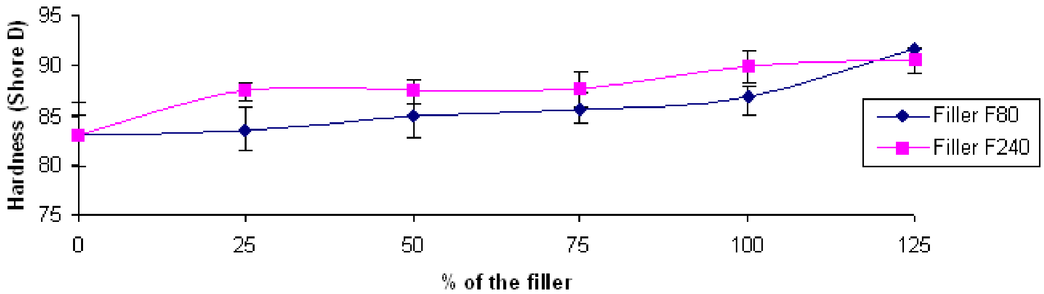


Fig. 2. **Hardness Shore D – non-sediment layer**

The results of the impact resistance $a_n$ test are presented in the following Figure 3. The presence of the mechanical surface treatment process waste based filler influenced the impact resistance in a negative way. The impact resistance of the material with no filler (etalon) was 8.99±1.28 $KJ \cdot m^{-2}$. With increasing share of the filler in the matrix the impact resistance figures dropped as low as 2.4 $KJ \cdot m^{-2}$. The most considerable drop in the impact resistance was recorded between 0 and 50 volume per cent of the filler.

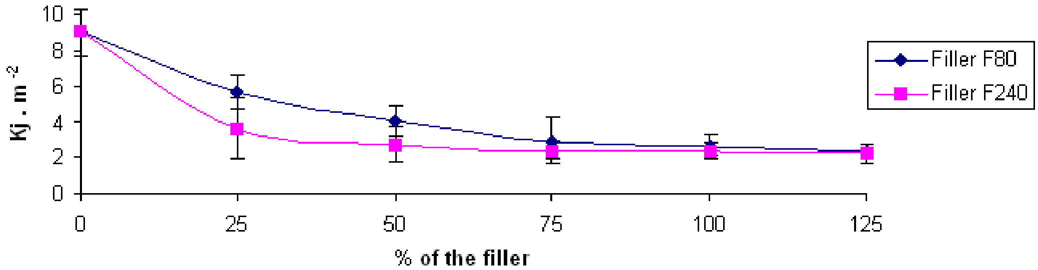


Fig. 3. **Impact resistance**

The results of the resilience tests to abrasive wear of the polymeric particle composites tested are listed in Graph 4. The resilience to abrasive wear of the separate samples is in percentage related to etalon, the material without filler. It is safe to say, that the presence of the mechanical surface treatment process waste based filler influences the resilience to abrasive wear in a positive way. The experiments conducted have not proven the extent of wear being dependent on the share of the filler in the matrix. The lowest figure 1.6 % compared to the wear of etalon was recorded for the sample F240 with 25 volume per cent on the filler in the matrix. Improvement in the resilience to abrasive wear for the tested composites of both the F80 and F240 fractions fluctuates between 6.6 and 1.6 % compared to etalon (100 %).

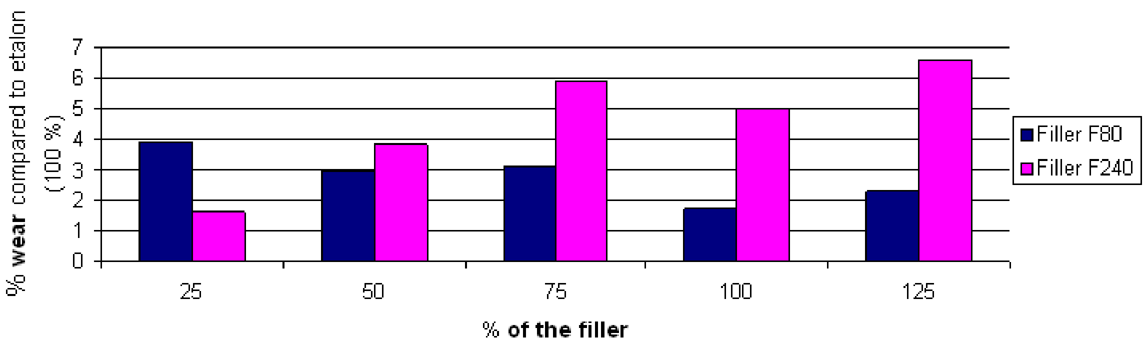


Fig. 4. **Resilience to abrasive wear**

## Conclusions

The presence of the mechanical surface treatment process waste based filler improves some of the tested mechanical properties of the composites created as opposed to the properties of the epoxy resin itself. They are in particular resilience to abrasive wear and hardness. However, the experiments confirmed the hypothesis of Vocel and Dufek [2], stating results of epoxy resins' tests with different kinds of fillers, which have a significantly higher resilience to abrasive wear than the polymer itself. But the aforementioned filler in the matrix deteriorates impact resistance. Based on the experiment conducted we can conclude that materials with mechanical surface treatment process waste based filler in the matrix can be applied mostly in renewal of mechanical parts and in the fields of bonding and puttying. When using these materials it is imperative to find an optimal compromise between the markers given. It is in technical application, where materials are often exposed to the impact of abrasive wear.

Mechanical surface treatment process waste as a secondary material in the matrix of polymeric particle composites replaces the primary material. Application of these materials as composite filler can be considered a form of recycling, which should be preferred. Materials produced this way are more economical and more environmentally friendly.

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