EFFECT OF THE COUPLING AGENT ON THE ADHESION OF PHASES IN CERAMIC-ELASTOMER COMPOSITES

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Keywords: Ceramic- polymer composites, infiltration, coupling agent

Abstract

In this paper ceramic-elastomer composites with percolation of ceramics and elastomer phases were reported. They were obtained using segmented urea-urethane elastomer, which was infiltrated as a reactive mixture of the substrates in the liquid form into pores of Al_2O_3 ceramic preform. The effect of the N-2-(aminoethyl)-3-aminopropyltrimethoxysilane coupling agent on the adhesion of both phases in ceramic- elastomer composites was shown. The degree of wetting was estimated by the value of contact angle as a function of coupling agent amount. The adhesion between phases was estimated from the shear strength.

1 Introduction

Ceramic-elastomer composites with percolation of ceramics and elastomer phases are new class of structural materials with significant application opportunities. They are obtained via infiltration of porous ceramics by elastomers. Effective reinforcement in composites requires good bonding between the filler and the matrix. The coupling agents can be applied to enhance wetting through their effect on the surface energy. There is a direct correlation between a good wetting and interfacial bonding that finally results in a good adhesion [1-6].

2 Materials and testing methods

Ceramic-polymer composites were obtained from segmented urea-urethane elastomer, which was infiltrated as a reactive mixture of the substrates in the liquid form into pores of Al_2O_3 ceramic material. Urea-urethane elastomer was synthesized by one-shot method from the 4,4'-diphenylmethane diisocyanate (MDI), ethylene oligoadipate (OAE) with average molecular weight 1906 a.u. and dicyandiamide (DCDA) as a chain extender. Ceramic performs were obtained by sintering using hot isostatic pressure. For each ceramic preform the porosity was at the same level, approximately 40 vol.%. The N-2-(aminoethyl)-3-aminopropyltrimethoxysilane coupling agent (U-15), supplied by UNISIL Tarnów, was used to improve the wetting and in the consequence the adhesion between Al_2O_3 ceramics and urea-urethane elastomer. It was infiltrated into the ceramic pores as a solution in toluene. Next toluene was evaporated in the vacuum at elevated temperature.

SEM observations of ceramic-elastomer composites were carried out on sections and fracture surfaces. The degree of wetting was estimated by the value of contact angle as a function of kind, amount and the way of applying of coupling agent. Shearing tests of composites were also performed to estimate the influence of coupling agents on composite shear strength.

3 Results

SEM investigations proved that through the infiltration of ceramic porous preform by elastomer, when coupling agents (U-15) was applied, composites with pores fully filled by elastomer were obtained (figs.1 and 2).

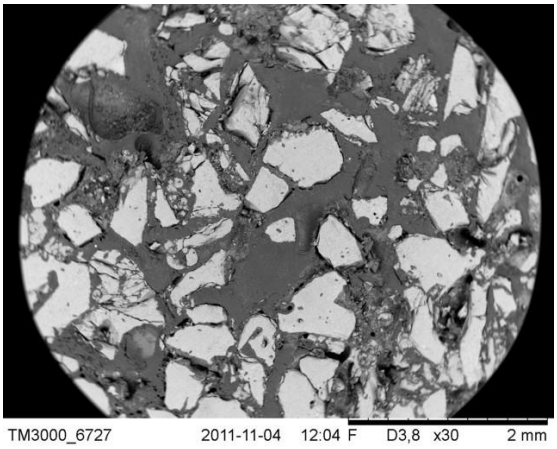

Figure 1. Microstructure of Al_2O_3/PU2,5 composites

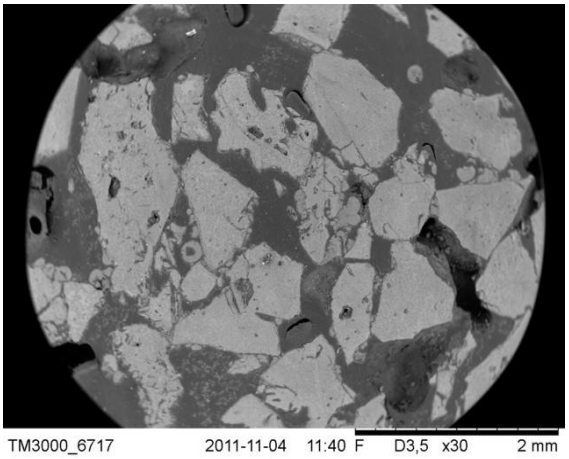

Figure 2. Microstructure of Al_2O_3/PU2,5+U15 composites

The degree of wetting was estimated by the value of contact angle as a function of amount of coupling agent. The lower value of contact angle provides the better wetability. Applying 5vol% of U-15 coupling agent leads to decrease of contact angle (fig.3).

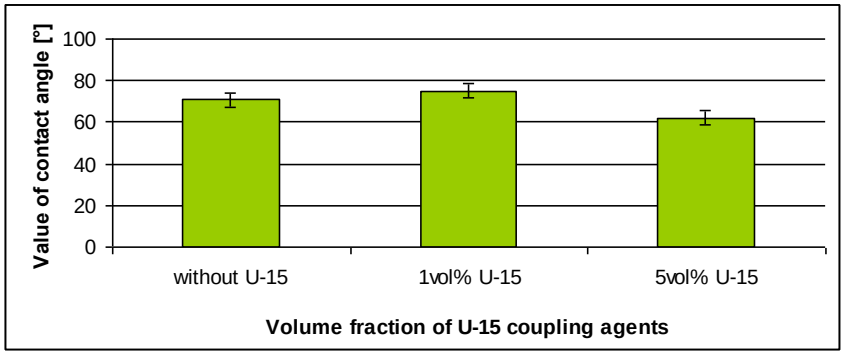

Figure 3. The effect of the coupling agent on contact angle

Shearing tests of composites were also performed to estimate the influence of coupling agent on composite shear strength. The results of the studies proved that using U-15 had an effect on shear strength of composites (fig. 4).

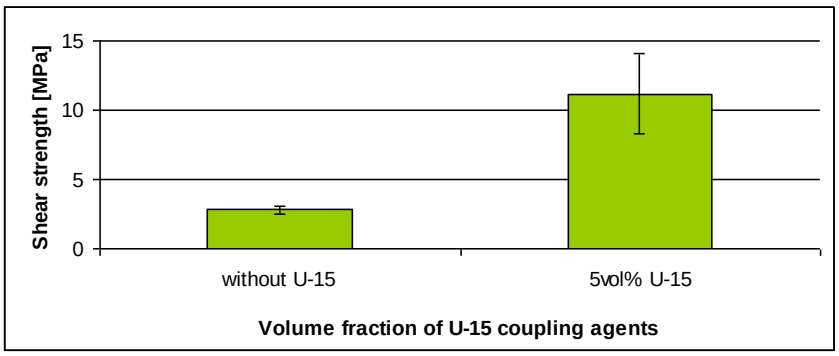

Figure 4. The effect of the coupling agent on shear strength of Al_2O_3/PU2,5 composites

4 Conclusion

The values of contact angle, SEM observations and shear strength of ceramic- elastomer composites proved that application of U-15 coupling agent leads to the improvement of adhesion between Al_2O_3 and urea-urethane elastomer. Addition of 5vol% U-15 ensure lower values of contact angle compared with lower volume fraction of coupling agent. The lower values of contact angle the better wetability of components of composites. It was found that addition of silane coupling agent improves adhesion between urea-urethane elastomer and ceramic.

Acknowledgements

The studies were supported by the Polish National Center for Research and Development as grant no. N R15 0021 06.

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