

Marko Maciej: „Examination of the Influence of Macromolecular Diffusion on the Interphase Formation between Adhesives and Adherends in Bonding Plastics“

This thesis deals with the examination of the influence of polymer diffusion on adhesion in polymer bonding of poly(St-co-AN) with an adhesive based on polyethylmethacrylate. Until now bonding by means of reactive adhesives is considered to be purely dependent on van-der-Waals forces between macromolecules. A contribution of diffusion is not at all regarded, although investigations in plastic welding prove such phenomena to be important factors in strength formation across polymer interfaces.

This thesis is divided into three parts. The first one deals with the choice of the materials to be used as adherends and adhesive respectively. This choice was done based on the knowledge of the conditions of polymer diffusion. For this reason there had to be ensured a sufficient consideration of the crucial parameters miscibility and temperature. Furthermore the choice of materials was to be done in such a way that analysis of the short diffusion distances was possible. Because of these restrictions polyethylmethacrylate was chosen as adherend and poly(St-co-AN) as a model adhesive. The bonded samples were analysed by transmission electron microscopy and quantitative image analysis.

The second part of this thesis deals with the analysis of interfaces between adherends and adhesives formed by macromolecular diffusion. Furthermore the dependence of diffusion on miscibility and temperature is analysed. For that reason experiments depending on the miscibility behaviour of the polymers were carried out at different temperatures. After that fitting of the experimental data was done by means of mathematical models based on the laws of fickian and case II diffusion.

The third part of this thesis deals with mechanical testing of adhesively bonded joints. Testing was done both by a shear tension test and a modified wedge test. From these experiments conclusions should be drawn on the influence of the interphase structure on the macroscopic mechanical properties.

It was shown that even in plastic bonding by means of reactive adhesive systems diffusion is occurring. These migration processes lead to interphases with an extension of up to 300 nanometers. The experimentally determined concentration profiles showed neither fickian nor case II character as could be shown by mathematical modelling. The results give rise to the assumption that under these conditions migration of macromolecules is ruled both by mechanical relaxation and diffusion. Due to the brittle character of the polyethylmethacrylate adherends there seemed to be no influence of polymer diffusion on joint strength. Either form of mechanical testing lead to fractures of the polymeric adherends so that the interface between the adhesive and the adherends could not be investigated.