Molecular spectroscopy of ultrathin polymer interfaces

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The characterization of the molecular structures of the interphase between two or more different polymers is important as structural variations within interphase influence the stability of the polymer composite. This is in particular true for novel polymer surface modification techniques.

An example of surface modification is the covalent coupling of amines on the surface of bisphenol-A based polycarbonate (PC). PC is a widely used engineering polymer with excellent optical and mechanical properties. However, PC has a hydrophobic surface and is therefore less suitable for biochemical application. A primary amine, octadecylamine (ODA) can be used to modify surfaces of PC in order to alter hydrophobicity, wettability and to further prepare biocompatible surfaces. Due to the diffusion-controlled reaction regime the thickness of the PC – ODA interphase is in the range of a few nanometers. Vibrational spectroscopy, such as infrared (IR) and Raman spectroscopy, has the potential for identification and accurate determination of the molecular structure. Moreover, surface enhances Raman spectroscopy (SERS) allows a very sensitive characterization of the interface, even under in-situ conditions in a non-destructive way. In this case small metal particles have to be incorporated into the interface before the polymers come in reaction.

In this contribution we demonstrate that IR and SER spectroscopy along with the spectroscopic background information is a suitable technique to resolve and to identify reaction products of the PC – ODA interphase.

Briefly, the reaction of PC with ODA is a complex solid state reaction which leads to several reaction products. Experimental IR spectroscopy, performed on several PC – ODA test samples revealed that an interfacial link between both materials is mainly formed by urethane groups. However, beside urethane other reaction products and even degradation products are also formed. SERS was applied to study the reaction under in-situ conditions. The surface enhancement effect enables for the first time to characterize the reaction between both polymers in-situ and without destroying of the material.

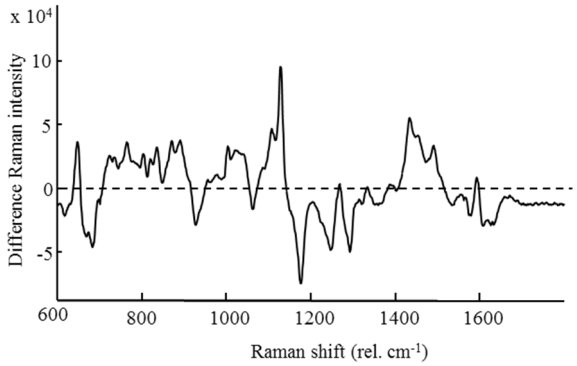

Fig. 2 SERS difference spectrum of a PC – ODA interface "after" – "before" the chemical reaction. Negative bands indicate a depletion of PC and ODA while positive bands can be assigned to the expected reaction products.

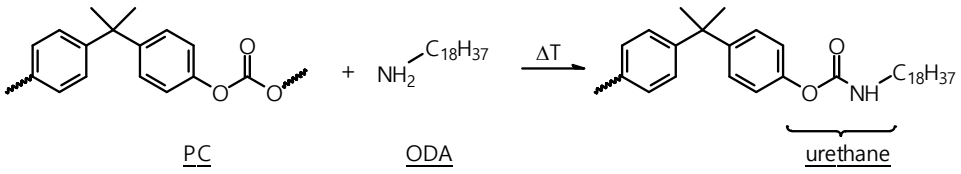

Fig. 1 Simplified reaction scheme of PC with ODA.