Polymers at Surfaces and Interfaces at ZHW

Martina Hirayama*, Pascal Dotta, and Heiner G. Bührer

Abstract: The properties of solids and liquids are strongly influenced by surface phenomena. At the interface of two phases, properties like wetting, adhesion and friction are determined by the degree of interaction between the phases. Controlling this interaction by means of chemistry at interfaces represents the major research topic of the Laboratory of Industrial Chemistry at ZHW.

Keywords: Blends, Coatings, Composites, Interfaces, Polymers

Layered silicates have been the subject of many studies. They contain exchangeable interlayer and surface ions. Since unmodified layered silicates hardly disperse in polymers, the sodium and calcium cations of the layered silicates need to be replaced by organic cations, e.g. organoammonium compounds. The cation exchange on the one hand separates the silicate layers giving a suitable plate-like nanofiller. On the other hand, the organic cations render the resulting organosilicate organophilic enough to be homogeneously dispersed in the polymer [1]. Depending on the size of the organic cations used for ion exchange, intercalation of the polymer into the silicate layers for small cations or a complete separation of the silicate layers for large cations (exfoliation) may occur (Fig. 1a). Although many studies on ion exchange of layered silicates can be found in literature, the temperature stability of the modified layered silicates is still a problem. We currently investigate together with EMS-Chemie AG the ion exchange of layered silicates targeting enhanced temperature stability together with enhanced mechanical properties and reduced permeability to gases of polyamide composites.

Also SiO₂, TiO₂, ZnO and other inorganic particles are widely used as fillers. In a current project we reinforce a poly(di-methylsiloxane)-based polymer with silica nanoparticles. The filler is expected to have two beneficial effects, namely a better abrasion resistance of the intrinsically soft material and a nanostructured surface leading to a hydrophobic effect (lotus effect). In order to disperse the silica nanoparticles in the polymer matrix, their surface is chemically modified (Fig. 1b). Since the material should be transparent, the silica particles have to be homogeneously dispersed to avoid agglomeration which causes significant scattering of light.

Beside technical polymeric composites, nature gives some outstanding examples of successful composite materials, e.g. teeth and bones in mammals and marine diatoms (Fig. 1c). Biological composites generally consist of a matrix, formed by organic macromolecules like collagen or chitin, and a mineral phase like calcium carbonate, silicon dioxide or apatite [2]. Considering the high performance of these materials and the capability of nature to perfectly control nucleation and crystal growth, biomimetic approaches to composites are a new and challenging field of research in our group.

Polymer Blends

Mixing two polymers in order to obtain materials with new properties represents...