

Immobilisation of nanoparticles on polymer surfaces via melt processing

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Nanoparticles and, particularly, nanoparticle aggregates exhibit some very interesting properties which may be used in advanced devices. Some examples are information storage, sensors, microfluidics, or switchable surfaces. For most of the applications, the nanoparticle structures have to be immobilized reliably on solid surfaces.

We followed an approach used for process-integrated surface modification of thermoplastic parts during injection molding. Hereby, the special state of the melt was used for chemical reactions on the melt once it hits a thin layer of a reactive and functional macromolecule, applied on the mold surface in advance. According to our approach, a layer of nanoparticles was prepared on a solid substrate by adsorption from colloid solution. In most cases, a layer of a polycation was adsorbed first to alter the substrate surface charge. Nanoparticles of gold, silica and a polymer were investigated. The surfaces of the particles were chemically modified. The layer was characterized by different spectroscopic and microscopic techniques. The particles were randomly distributed over the surface. In some cases chain-like aggregates were formed. The behavior of the layer in contact with the flowing melt was investigated. Finally, the surface of the part produced by injection molding was characterized.

It was found, that the nanoparticles were not shifted by the flowing melt. No re-mixing with the flowing melt occurred. The distribution on the thermoplastic part surface was also randomly. Even aggregates from the substrate surface were reproduced. This may be a result of the fast cooling of the melt as it comes in contact with the mold. The process is analyzed by thermal simulation. The degree of embedding (see figure 1) depended on the size and surface properties of the particles. Thus, the embedding depth can be controlled. Some of the particle surface area was accessible for small molecules from solution. This was demonstrated by their catalytic activity in a redox reaction and by their adsorption behavior. Those embedded nanoparticle layers may be used in microfluidics or sensor applications.

Consequently, the contribution addresses aspects of manipulation and engineering of nanoparticle systems under conservation of their typical properties. With the method introduced, the economic manufacture of parts with surfaces functionalized with nanoparticles becomes possible.

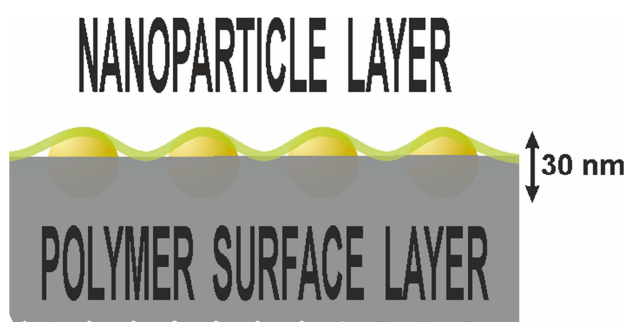


Figure 1 Schematic of the arrangement of nanoparticles on the thermoplastic part surface. The particles are partly embedded, thus immobilized but their surface is still accessible for small molecules.