MAGNETIC AND CONDUCTIVE POLYMER COMPOSITES

Petr Saha

Tomas Bata University In Zlín
rektor@utb.cz

Polymers filled with magnetic particles are widely used for high-frequency devices as electromagnetic wave absorbers or antennas as well as in medicine, in particular in hyperthermia for combined treatment of cancer. This is to be explained by the fact that in magnetic polymer composites the relative complex permeability in the high-frequency region becomes larger than that of the bulk magnetic materials. Moreover, the magnetic spectra of composites could be easily modified by the concentration, shape, size and arrangements of magnetic particles in polymer matrix, so by changing of composite morphology. The main challenge is to design such a structure of magnetic polymer composites that would have the greatest effect on the electromagnetic properties. A promising way of improving the high-frequency permeability of magnetic polymer composites is the development of a hybrid polymer composite system on the basis of multi-component fillers or multi-component particles combined with magnetic and conductive components. The advantage of such magnetic materials consists in combination of their electric and magnetic properties, which first of all provides their effective interaction both with electric and magnetic components of electromagnetic fields and then enables to control magnetic properties through electric ones and vice versa. Composites which include both ferrite and conductive filler lead to the enhancement of the absolute value of permeability in the high-frequency range compared with that of polymer composites with the same ferrite particles content. We have established that such an enhancement takes place when the concentration of the conducting filler in hybrid composites is above the electrical percolation threshold in the polymer composite with conducting filler. There is no significant difference in the magnetic spectra for hybrid composites with various conducting fillers (carbon black, Al powder, carbon fibber, polypyrrole) although they greatly differ in dc conductivity and complex permittivity. It is assumed that the observed effect is associated with the development of a core-shell-like structure in a hybrid polymer composite, where the core is a magnetic particle and the "conductive shell" is formed by conductive particles. Furthermore, some cases connected with electro- and magnetorheology will be presented.