EFFECT OF NANOPARTICLE FUNCTIONALIZATION AND AIR HUMIDITY ON THE DIELECTRIC PERFORMANCE OF EPOXY-BASED COMPOSITES

Philipp Marx[a,b], Andrea J. Wanner[a,b], Zucong Zhang[a], Huifei Jin[c], Ioannis-A. Tsekmes[c], Johan J. Smith[c], Wolfgang Kern[a,b], Frank Wiesbrock[a]

[a] Polymer Competence Center Leoben (PCCL), 8700 Leoben, Austria
[b] Chair of Chemistry of Polymeric Materials, MU Leoben, 8700 Leoben, Austria
[c] Department of Electrical Sustainable Energy, Delft University of Technology, Mekelweg 4, 2628 CD Delft, The Netherlands

Epoxy resins are abundantly used as insulating compounds. In order to enhance their dielectric properties, nanocomposites [1] of an epoxy/amine resin and one type of fillers (SiO_2, surface-silylated SiO_2, Al_2O_3, surface-silylated Al_2O_3, and BN; Figure 1) were prepared. The nanocomposites containing pristine silica showed the lowest permittivity of the series. An explanation can be derived from the Tanaka model [2]. Interaction of the functional groups of the polymer and the surface of the nanoparticles disturbs the mobility of dipoles in the polymer matrix, which decreases the permittivity. The dried samples acted as dielectrics over a broad frequency range (10^{-2} to 10^{6} Hz). Water absorption under ambient conditions significantly increased interfacial polarization and, consequently, deteriorated the insulating properties. This effect was most pronounced in the case of nanocomposites containing fillers such as pristine silica (Figure 1) with polar surfaces that are able to interact with water molecules. On the contrary, the composites containing nanoparticles with a hydrophobic surface (such as surface-silylated silica) showed good dielectric properties even upon the absorption of water.

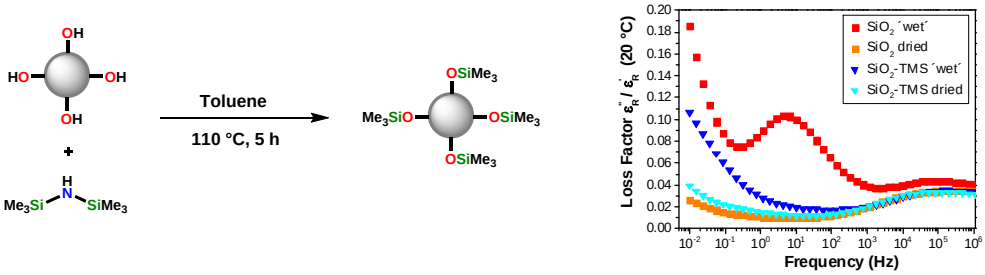

Figure 1: Left: Surface functionalization of silica and alumina nanoparticles with hexamethyl disilazane. Right: Loss factors of pristine and surface-silylated silica nanoparticles (`wet´ and dried samples).

[1] I. Plesa, P.V. Notingher, S. Schlögl, C. Sumereder, M. Muhr, *Polymers* **2016**, *8*, article 173 (63 pp.).

[2] T. Tanaka, M. Kozako, N. Fuse, Y. Ohki, *IEEE TDEI* **2005**, *12(4)*, 669-681.