TERAHERTZ SPECTROSCOPY OF AGED EPOXY POLYMERS

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The detection of aged material is of outmost importance for quality control in long-term used polymer materials. Especially epoxy-polymers represent an interesting material class as they are the basis of many modern adhesives. In order to detect aged materials, destructive mechanical tests are commonly used. In this study, we investigate cured out plates of Polytec EP601-T epoxy adhesives, which are thermally aged at 100°C, UV irradiated or inserted in pure water each for one week using a standard fiber-coupled THz TDS system.

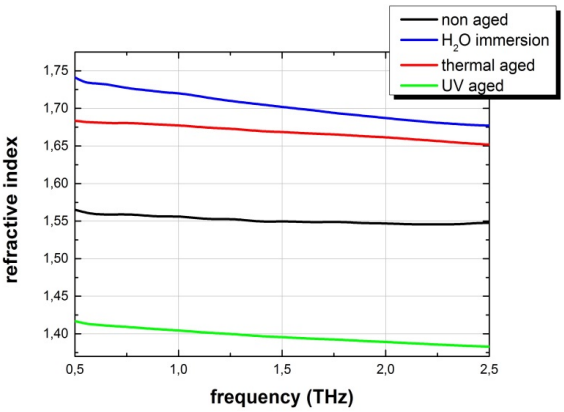

Fig. 1. Refractive index of different aged epoxy polymers over a frequency range 0.5 up to 2.5 THz.

The refractive index of the samples after ageing varies significantly. Figure 1 illustrates the frequency dependent spectra of the refractive index of the different aged epoxies. The refractive index of non-aged polymers is about 1.55, whereas it increases during thermal aging. Here post-cure and cross-link effects of the epoxy molecule may occur and the morphology changes. During the water immersion, the water molecules are embedded in the polymer matrix and therefore the refractive index increases, as previous studies suggested. However, the decrease of refractive index during UV irradiation is more interesting. Probably the long chains of epoxy molecules get cracked into smaller ones.

In summary, with THz TDS it is possible to characterize aged epoxy polymers nondestructively by comparison of their refractive indices.