THz-ToF Techniques for the Detection of Inherent Discontinuities in Dielectric Materials Based on a SAFT Algorithm and an Optical Layer Algorithm

Holger Spranger and Jörg Beckmann, Bundesanstalt für Materialforschung und –prüfung (BAM), Berlin

T-rays are electromagnetic waves with frequencies between 0.3 and 10 THz. The ability to penetrate dielectric materials makes them attractive to reveal discontinuities in polymer and ceramic materials. THz-Time Domain Spectroscopy Systems (THz-TDS) are available which operates with THz-pulses. In THz-TDS the travelling time (ToF) and shape of the pulse changes if it interacts with the basic material and its discontinuities. Several reconstruction techniques have been already demonstrated in the context of THz-ToF [1]. Nevertheless, tomographic reconstruction procedures, developed for x-ray computed tomography (CT) applications, have been preferably applied. As a result, reliable tomograms could be presented in case of existing minor refraction property differences between the defect and its surrounding material. Nevertheless geometric artefacts could be observed [2]. The strong restriction of the CT application for the inspection of dielectric plastics that engaged us to develop a reconstruction technique that takes refraction into account. A time domain SAFT based algorithm will be presented, which is able to visualize discontinuities properly in dimension and location, if the base materials shape and its refractive index are considered (Figure 1). The algorithm became more challenging in case of multilayer composites. For that reason an Optical Layer algorithm was developed. Measurements on representative samples with a variety of artificially produced small and large size defects will be shown. The calculated tomograms will be demonstrated to discuss and evaluate the benefits and limits of the two different reconstruction approaches.

Figure 1: The influence of the refractive index profile on the SAFT reconstruction of a cylindrical sample with embedded copper wires

a) total reconstruction area was assumed to have only one constant index (n=1.5)  
b) reconstruction area consists of cylindrical PE matrix (n=1.5) and air (index profile)

References: