## 1.5.16. CAPABILITY OF TERAHERTZ-WAVE INSTRUMENTATION FOR NON-DESTRUCTIVE TESTING OF LIQUIDS

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Electromagnetic waves with frequencies between 0.3 and 10 THz ≡ 10 – 300 $cm^{-1}$ ≡ ≡ 1 – 0.03 mm are described as THz-radiation (T-ray). They are assigned in the electromagnetic spectrum between the microwave/millimetre and the far-infrared regions. The ability to penetrate packing materials, such as paper, cardboards, plastic, glass and clothing and its non ionizing character make THz radiation very attractive for different imaging and spectroscopic applications. Especially the security sector directed the attention to the new developments of the THz-technologies. Transmission and reflection properties of the solid explosives such as e.g. HMX and RDX were studied intensively to reveal characteristic "fingerprint" absorption spectra for further material identification during security checks. Recently, the visualisation and verification of liquid explosives and flammable liquids became important. The literature reports only on few related THz spectroscopy experiments.

The THz instrumentation has been experienced a fast development. Modern Time Domain Spectroscopy Systems changed from conventional open beam systems to glass fibre coupled devices. The new systems offer more flexibility and are designed also for mobile handheld application and not for laboratory use only.

The THz laboratory at BAM is equipped with a glass fibre coupled Picometrix T-ray 2000 THz system and a Huber two circles goniometer system, where both sample and detector can be moved independently. Subsequently THz Time Domain Spectroscopy (TDS) experiments can be carried out either in transmission or in reflection geometry. The experimental set up allows a fast switching between transmission and reflection mode without major changes. Measurements at different incident, reflection and transmission angles between 0° and 90° can be performed.

THz inspections of petroleum products (e.g. gasoline, kerosene, gasoil) and some non polar liquids (e.g. benzene, toluene, hexane) were carried out in the frequency range of 0.3 to 2 THz. The products have been studied mainly in transmission geometry at different experimental procedures. In contrast to the non polar liquids, polar liquids could only be accessed at the reflection mode due to the high absorption in the THz range. Preliminary experiments with water, acetone, hydrogen peroxide and ethanol indicated already a blocking of the transmitting THz beam in the above described THz Spectrometer at a layer thickness of 1mm. Nevertheless, the THz-TDS results demonstrate the opportunities of non-destructive contactless inspections of polar and non polar liquids in transmission and reflection mode.

The results will be compared and complemented with conventional far infrared FTIR measurements. The work is part of the financially supported BMBF project "HANDHELD" (FKZ: 13N9514).