TERAHERTZ TECHNOLOGY FOR INDUSTRIAL APPLICATIONS

Terahertz (THz) technology is currently close to its application in industry. It has several advantages that make it a tool for the contactless and non-destructive investigation of many nonconductive materials (e.g., plastics, paper / cardboard, ceramics, chemicals, pharmaceuticals):

- High penetration depths, e.g., for plastics in the range of cm (advantage over neighboring IR)
- Better spatial resolution (mm to sub-mm) compared to adjacent microwaves
- Non-ionizing (advantage over x-rays)

Facts

- THz radiation is located in between the microwaves and infrared (IR) in the electro-magnetic spectrum.
- THz radiation is strongly absorbed and/or reflected by water (polar substances) and by conducting materials.

Technology

We apply a time-resolved measuring principle, in which pulsed THz radiation is deployed (via a femtosecond pulse laser). This technique allows for depth-resolved and spectral information.

Scope of Applications

THz-physical Properties

- Determination of layer thickness (e.g. coatings, multi-layered boards and composite tubings, tablets)
- Index of refraction, absorption coefficient

THz-Spectroscopy (chemical properties)

- Qualitative and Quantitative characterization and identification via fingerprinting, e.g. of explosives, crystalline substances (e.g. active pharmaceutical ingredients), polymers, oils
- Analytics: Optical Isomers (chiral), conformational isomer (e.g. chair/boat), polymorphs, as well as their phase transitions and determination of mixing ratio
- Water content and water of hydration

THz-Imaging (see examples on rear side)

- Polymers and plastics, paper / cardboard, ceramics, textiles, foodstuff etc.
- Investigation of inclusions, defects, etc. (position, depth)
- Quality of interfaces (e.g., between plastics, plastic – metal)
- Delaminations / defects in GRP materials, etc.

Polarization sensitive measurements (also imaging)

- E.g. determination of fiber orientation in fiber reinforced polymers

Hyperspectral Imaging

- Combination of imaging and spectroscopy as well as determination of physical properties

New!

- Fiber-coupled system for the physical separation of detector head and measurement and monitoring system

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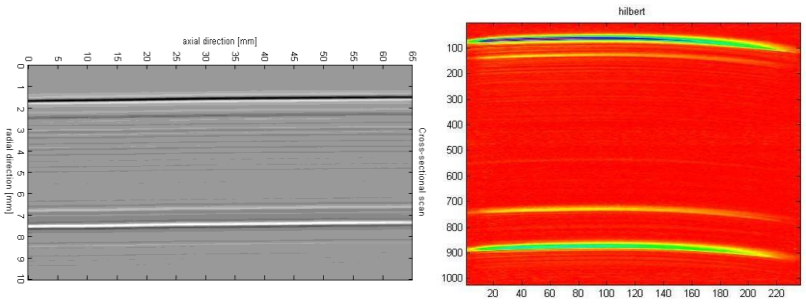
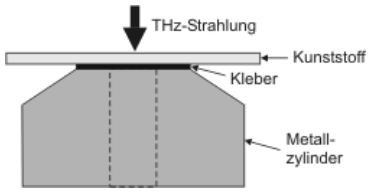
BANKVERBINDUNG Allgemeine Sparkasse Oberösterreich | Kto-Nr.: 32100-102048 | BLZ: 20320 | IBAN: AT262032032100102048 | BIC: ASPKAT2L

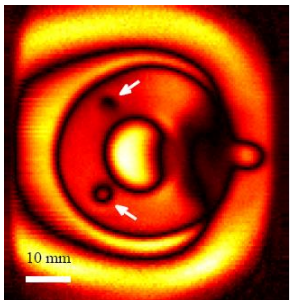
Examples of Applications

- composite polymer tubings [1]
  - Tube left: 3 layers, total layer thickness: 2 mm, outer layer: 0.5 mm
  - Tube right: 3 layers, total layer thickness: 2 cm, outer layers: 1.5 and 3 mm

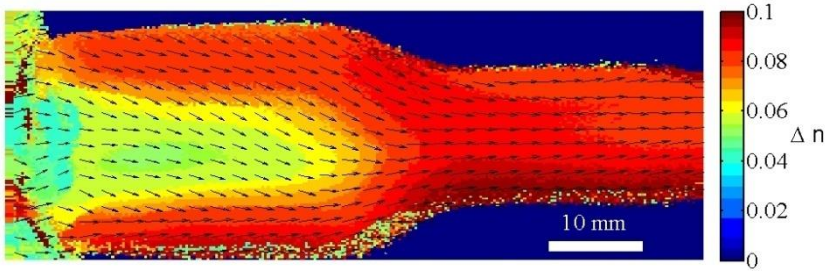


- Adhesive layer (automobile industry; left: without, right with defects; [2])





- Fiber-reinforced polymers; [3]



Referenzen:

[1] Probe: Institut für Polymer Extrusion und Building Physics, Johannes Kepler Universität Linz.
[2] S. Katletz, M. Pfleger, H. Pühringer, N. Vieweg, B. Scherger, B. Heinen, M. Koch, and K. Wiesauer, „Efficient Terahertz En-face Imaging“, Opt. Express 19, 23042–23053 (2011).
[3] S. Katletz, M. Pfleger, H. Pühringer, M. Mikulics, N. Vieweg, O. Peters, B. Scherger, M. Scheller, M. Koch, and K. Wiesauer, „Polarization sensitive terahertz imaging: detection of birefringence and optical axis“. Opt. Express 20, 23025–23035 (2012). doi:10.1364/OE.20.023025.

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