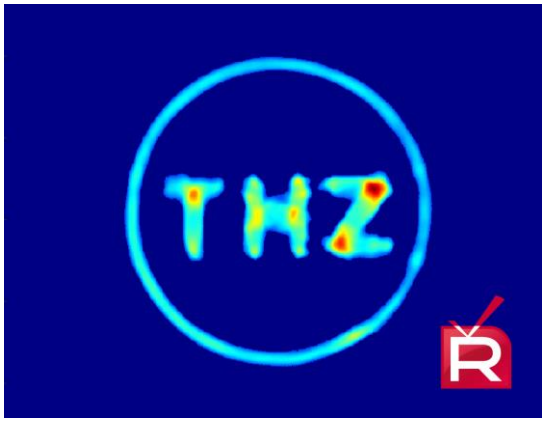
SUCCESS STORY

PSSP
Photonic Sensing for Smarter Processes

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Project

Duration: 2018 - 2022



TERAHERTZ-CT – COMPUTED TOMOGRAPHY WITHOUT THE RISKY "X"

CT IS A VERY POWERFUL TOOL, USALLY BASED ON X-RAYS, THAT DELIVERS 3D IMAGES OF A BODY'S INNER STRUCTURES. WHAT IF WE COULD REPLACE X-RAYS WITH NON-HAZARDOUS LIGHT?

Being able to reconstruct the 3D geometry of bodies or other objects can be of critical importance not only in the fields of medicine or art conservation but also in industrial production. Reconstructions are often carried out with X-ray computed tomography (X-CT), which is a powerful method, but also has its downsides, such as the necessity to shield the operators from its harmful radiation.

An alternative is to use Terahertz (THz) technology to scan and reconstruct objects. THz radiation, owing to its much longer wavelength and lower energy, can also penetrate deep into various materials and allow for imaging and reconstruction of objects – with the big benefit of being absolutely safe for humans at typical doses.

So far however, efficient solutions for THz computed tomography were lacking.

In the PSSP project, RECENDT built on recent advances in THz hardware to develop an innovative approach for THz CT. The new solution combines speed and high accuracy in a flexible setup, resulting in a user-friendly solution suitable for contactless and non-destructive quality control using THz-CT. Potential applications demonstrated during the project are accurate thickness evaluation and

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Version 01/2020

detection of hidden defects in reconstructed 2D profiles.

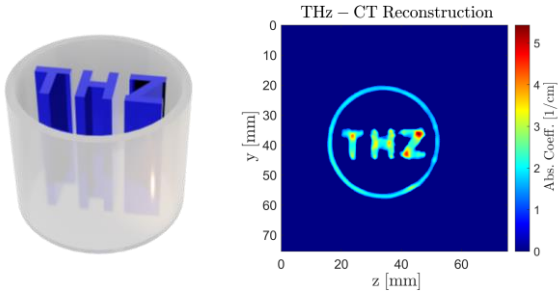
Industrial objects that lend themself very well to investigations using THz-CT are elongated 3D objects or "profiles" (e.g., window profiles or rubber seal) made of non-metallic materials such as plastics, wood, rubber, ceramic, etc. However, objects with other geometries can be investigated as well. THz radiation penetrates up to several centimeters into objects (depending on the material), enabling the detection of hidden defects such as wrong wall thickness, holes or inclusions.

The developed THz-CT approach is based on a novel combination of phase-contrast imaging with ray-tracing simulations. Together, the two allow an unprecedented thickness evaluation accuracy below 150 µm. The resolution, on the other hand, stays limited by the finite waist radius of the THz beam. Nevertheless, our system also detects holes and inclusions of sizes down to 1 mm.

Impact and effects

This new solution already attracted attention from the industry and was presented in online seminars of inVISION (magazine specialized on 3D metrology) and in the NDT4Industry series.

In addition to CT, the setup can easily be reconfigured to carry out fast THz imaging and spectroscopy. This is particularly interesting in the case of flat objects, e.g., for a transmission measurement through a multi-layer plate or a reflection measurement of a flat surface. This resulted in a collaboration with the company TOPTICA Photonics, which produces THz devices, to design and build a prototype for a fast spectroscopy and imaging platform based on developments done for the THz-CT setup in PSSP.



3D model of a 3D printed object and profile reconstruction using phase contrast THz-CT. © RECENDT

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Project partner

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This success story was provided by the consortium leader and by the mentioned project partners for the purpose of being published on the FFG website. PSSP is a COMET Project within the COMET – Competence Centers for Excellent Technologies Programme and funded by BMK, BMDW, the Federal State of Upper Austria and the Federal State of Styria (represented by the "Steirische Wirtschaftsförderungsgesellschaft m.b.H. - SFG"). The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet

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