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Terahertz systems and components in industry

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Terahertz technology has reached a level of maturity that enables its successful deployment in industrial environments. Advances in system core components – sources, detectors, and quasi-optical elements – and measurement techniques – time-domain and frequency-domain approaches of signal generation, detection, acquisition and processing – have led to increasingly efficient and compact systems at cost levels that make industrial applications financially viable.

At Fraunhofer ITWM, research and development focuses on customized terahertz systems for applications, such as layer thickness measurement, material characterization, and nondestructive testing (NDT) [1]. Both terahertz time-domain spectroscopy (TDS) and all-electronic frequency-modulated continuous wave (FMCW) radar systems are employed for defect detection and quality inspection, complemented by recent optoelectronic frequency-domain approaches [2]. Beyond the measurement hardware itself, system integration at ITWM addresses typical challenges of industrial environments including integration into production lines, matching process speeds, and ensuring system robustness. We present several projects in which terahertz systems have already been successfully deployed in industrial processes.

One key enabler for next-generation customized systems operating in the EHF and THz frequency range are high-performance, compact components. In this context, we introduce results from our TERA-AMP project – a collaboration between Fraunhofer ITWM and Düsenfabrik Leipold GmbH – which pioneers the use of 3D laser microprinting to fabricate interface structures between waveguides, microstrip lines, MMICs, and free space. This additive manufacturing approach enables independent sourcing of MMICs with arbitrary geometry, the integration of additional functionality directly into printed interface components, a massive reduction of manual assembly steps, and rapid progression from design to ready-to-use components.



Different systems developed at Fraunhofer ITWM for industrial applications.

REFERENCES

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