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Terahertz spectroscopy of wood and combustion gas

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Applications development using terahertz technology has seen exponential growth in recent years, thanks in part to the availability of inexpensive, tabletop systems. One of the unique aspects of THz technology is that it exploits coherent detection to map the electric field directly in time, allowing researchers to probe dynamics on the picosecond time-scale, referred to as THz Time-Domain Spectroscopy (TDS). This contribution will compare experiments to model calculations for the time-domain THz response of gas and solid phase mixtures used for applications in emissions monitoring from combustion systems and probing wood properties.

The entire rotational manifold of thermally populated rotational states in many molecular systems can be completely covered by a single THz pulse with a bandwidth of 3 THz. Many gases produced in combustion, such as CO and NO, are linear molecules with roughly even frequency spacing of the absorption peaks in the THz range. This leads to interesting relaxation time dynamics (commensurate echoes), which can be used to probe and quantify gases (THz-TDS). In this contribution, a model for the time-domain response will be presented for Nitric Oxide (NO) and compared to experiments, and the implications for emissions monitoring discussed.

The time-domain response of transmitted THz signals through solid composite materials such as wood is more complicated due to a macroscopic physical structure, which requires an effective medium approach. Using such a model, it is possible to predict density, thickness and moisture content of wood samples using THz measurements. Recent work towards simultaneous prediction of moisture content and density will be presented, and applications in the forest products industry highlighted.

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