Low-cost Thermal Infrared Spectrometer for Liquid and Materials Analysis

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Fourier Transform Infrared Spectrometers is a technique used to obtain an IR spectrum of a medium's absorption or reflection/transmission (e.g., solids, liquids, gases). FTIRs are tools that are widely used in several application industries. For example, identifying gases and their concentration in environmental, medical, industrial, security and defence applications; Identifying molecules in food and drug inspections; Remote sensing over long distances (e.g., open path gas analyser for detecting CO2 levels) and High-resolution Spectro microscopy and near-field imaging.

Commercial FTIR spectrometers are very bulky and/or expensive, mainly due to the coherent laser source, optical components and detectors being used. In this work, we describe a thermal infrared spectrometer based on the 'THz Torch' concept, which is used to characterise solid and liquid samples. The spectrometer comprises a thermal infrared emitter that acts as perfect blackbody radiation characteristics and a pyroelectric detector with low signal-to-noise (SNR) ratio. In addition, seventeen narrow-coated optical band-pass filters are selected to define a coarse set of different discrete spectral data points between 20 to 100 THz. Both transmission and reflection modes of operation are exhibited (within the extended THz range).

The 'THz Torch' technology benefits from room-temperature operation, being portable and low-cost hardware implementation. When complemented with machine learning, our results show the potential for non-destructive, non-invasive material characterisation. For example, this technology could be deployed at well sites in oil and gas rigs to support coiled tubing drilling (CTD) for extracting quantitative mineralogical and gas data from cuttings. No logging while drilling (LWD) technologies are currently available to help geosteering in CTD; this application could result in a better gas recovery rate from mature fields.