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Oil contamination detection using THz spectroscopy and imaging

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Crude oil production, although criticized in the context of global warming, remains high compared to previous decades and is growing [1]. Renewable energy and material sources are replacing crude oil products, but the industry is not going away anytime soon. The aim of this research is to find and propose new ways to detect, identify, quality control and monitor crude oil and its products using new optoelectronic tools to make the use of crude oil products safer for the environment and effective for the people. It has been previously established that the refractive index and absorption coefficient depend on the length of hydrocarbon molecules, and the presence of such bonds as esters fundamentally changes the trends in the dependence of optical properties [2]. In this regard, crude oil is the most complex medium for research in the class of petroleum products, since its chemical composition is extremely rich and diverse.

Five different viscosities of engine lubricant oils were purchased from local suppliers, as were 2 types of diesel from 2 different suppliers, and 1 type of petrol from 2 different suppliers. In the fuel study, pure fuels, both petrol and diesel, were mixed with a specified amount of contaminants commonly found in crude oil, namely water, methanol, isopropanol, and sulfur. Each type of fuel was separately mixed with 5% to 0.5% of contaminants.

Figure 1 shows the characteristic spectra for the sample groups, i.e. lubricant, diesel, petrol and crude oil. This work presents the spectra of crude oil and its products measured using Fourier transform THz spectroscopy in order to identify unique spectral features that could be used in complex characterization studies of oils. The work focus on the THz imaging at frequency of 253 GHz capabilities for fast and reliable detection of contaminants in crude oil and its products.

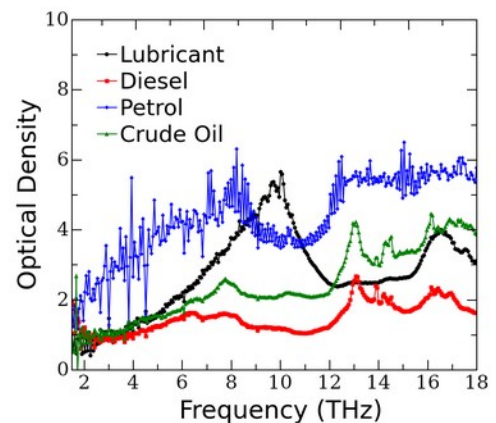


Fig. 1 The spectra of crude oil and its products, lubricant, diesel and petrol, were measured by Fourier transform infrared spectroscopy in the 1.5–18 THz.

REFERENCES

- [1] IEA, World crude oil production by region, 1971-2020, IEA, Paris, IEA.
- [2] M.~Karaliūnas *et al.*, Sci. Rep. **8**, 18025 (2018).