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Rapid, Automated Characterization of Microplastics Using Laser Direct Infrared Imaging and Spectroscopy

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Abstract : Over the last 3.5 years, Quantum Cascade Lasers (QCL) technology has become increasingly important in infrared (IR) microscopy. The advantages over fourier transform infrared (FTIR) are that large areas of a few square centimeters can be measured in minutes and that the light intensive QCL makes it possible to obtain spectra with excellent S/N, even with just one scan. A firmly established solution of the laser direct infrared imaging (LDIR) 8700 is the analysis of microplastics. The presence of microplastics in the environment, drinking water, and food chains is gaining significant public interest. To study their presence, rapid and reliable characterization of microplastic particles is essential. Significant technical hurdles in microplastic analysis stem from the sheer number of particles to be analyzed in each sample. Total particle counts of several thousand are common in environmental samples, while well-treated bottled drinking water may contain relatively few. While visual microscopy has been used extensively, it is prone to operator error and bias and is limited to particles larger than 300 µm. As a result, vibrational spectroscopic techniques such as Raman and FTIR microscopy have become more popular, however, they are time-consuming. There is a demand for rapid and highly automated techniques to measure particle count size and provide high-quality polymer identification. Analysis directly on the filter that often forms the last stage in sample preparation is highly desirable as, by removing a sample preparation step it can both improve laboratory efficiency and decrease opportunities for error. Recent advances in infrared micro-spectroscopy combining a QCL with scanning optics have created a new paradigm, LDIR. It offers improved speed of analysis as well as high levels of automation. Its mode of operation, however, requires an IR reflective background, and this has, to date, limited the ability to perform direct “on-filter” analysis. This study explores the potential to combine the filter with an infrared reflective surface filter. By combining an IR reflective material or coating on a filter membrane with advanced image analysis and detection algorithms, it is demonstrated that such filters can indeed be used in this way. Vibrational spectroscopic techniques play a vital role in the investigation and understanding of microplastics in the environment and food chain. While vibrational spectroscopy is widely deployed, improvements and novel innovations in these techniques that can increase the speed of analysis and ease of use can provide pathways to higher testing rates and, hence, improved understanding of the impacts of microplastics in the environment. Due to its capability to measure large areas in minutes, its speed, degree of automation and excellent S/N, the LDIR could also implemented for various other samples like food adulteration, coatings, laminates, fabrics, textiles and tissues. This presentation will highlight a few of them and focus on the benefits of the LDIR vs classical techniques.

Keywords : QCL, automation, microplastics, tissues, infrared, speed
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