Mapping microplastics on filter membranes using Raman microscopy: Capabilities and Limitations

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Abstract

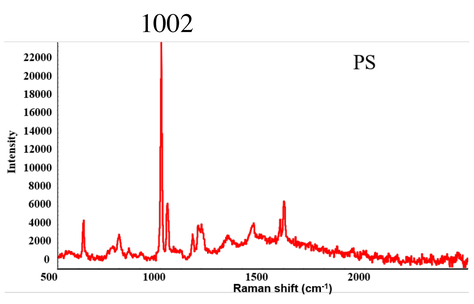
Microplastic contamination is widespread and has been highlighted as an emerging concern for human consumption due to their small size. Analysis of Polystyrene particles is of significant importance to evaluate the occurrence of microplastics in food for risk assessment. Herein, we described a filter-Raman mapping technique as a rapid approach for the recovery, identification, and quantification of microplastics of different sizes. The microplastics (1 µm &10 µm) dissolved in water were collected in Anodisac (Alumina) filters and scanned by Raman microscopy. The results showed that a low microplastics concentration of 10 particles/mL and individual microplastics down to 1 um in size were achieved using Raman microscopy. A positive correlation between the Raman image pixels and the microplastic amount measured was confirmed with a highest correlation coefficient of 0.9969. Overall, the proposed method shows potential for application in microplastics at smaller range (1 and 10 µm), while optimization work needs to be employed to reduce the interference from the food matrix.

Objectives

Determine capability and limitations of Raman Microscope to detect 10 μm and 1 μm in Polystyrene particles.

Results

Fig 1. the characteristic Raman spectrum of Polystyrene



1002 – Ring Breathing Mode

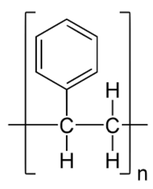


Fig 2. Polystyrene Structure

Methods

• Material and reagents

Microplastics: Polystyrene

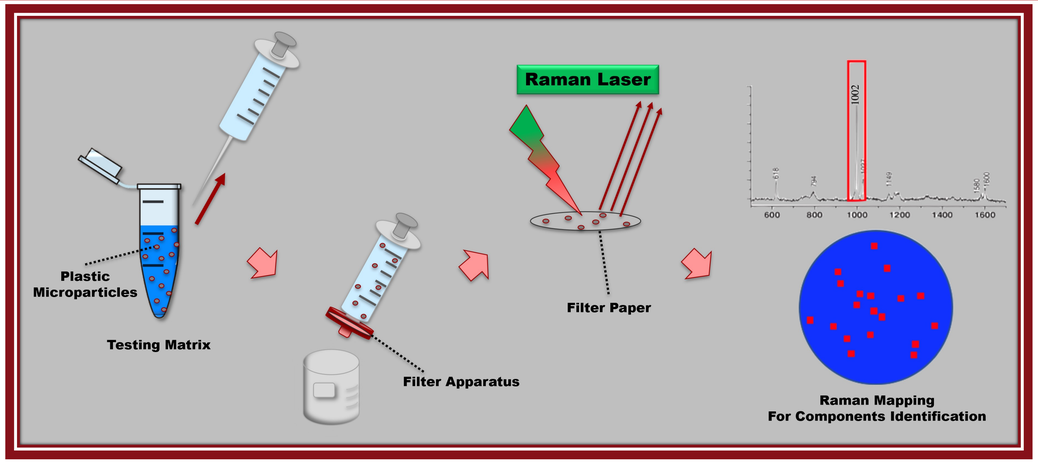
Filter: Anodisac (Alumina) filters – 13 mm

• Analytical Method

1. Filter assisted method

2. Raman Spectroscopy – Chemical analysis technique which provides detailed information about chemical structure, phase, crystallinity and molecular interactions. It is based upon the interaction of light with the chemical bonds within a material.

3. Raman Mapping – Method for generating detailed chemical images based on a sample's Raman spectrum. A complete spectrum is acquired at every pixel of the image, and then interrogated to generate false color images based on material composition and structure.



10μm Polystyrene (20x long lens)

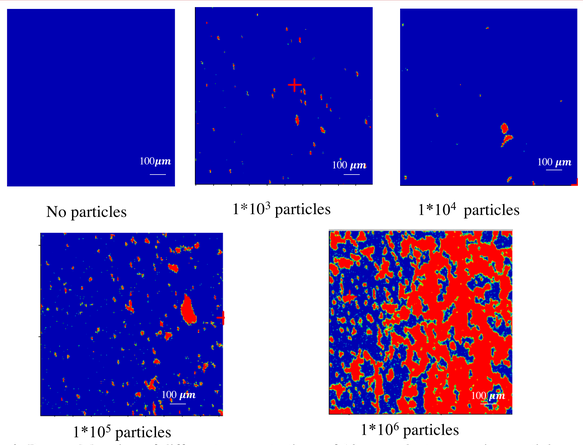
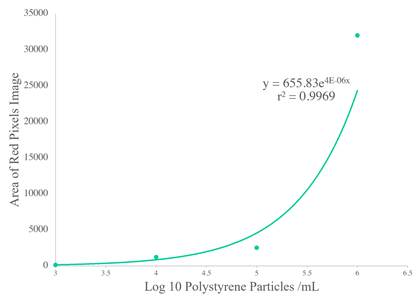


Fig.3. Raman Mapping of different concentrations of 10 µm polystyrene microparticles per mL at 1002 cm^{-1}



Parameters:
Laser Power = 24 mW
Exposure Time = 0.0200 sec
Number of Scans = 1
Image Pixel Size = 5.0μm
Preview Size = 270μm

Polystyrene – Red Particles

Fig.4. Quantitative analysis in terms of different concentrations of 10 μm polystyrene on filter mapping

1μm Polystyrene (100x long lens)

Parameters:
Laser Power = 10mW
Exposure Time = 1 sec
Number of Scans = 1
Image Pixel Size = 1
Preview Size = 50μm

Polystyrene – Red Pixels

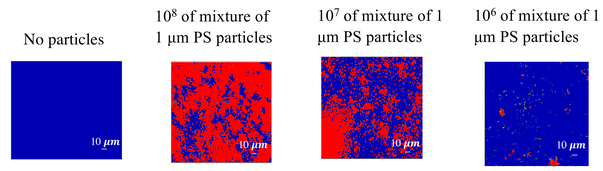


Fig.5. The Raman Mapping of different concentrations of 1µm Polystyrene particles at 1002cm^{-1}

Conclusions

10μm Polystyrene can be detected by Raman Microscope.

The detection of 1 μm microplastic is time consuming and it is difficult to detect single 1 μm microplastics.

The relationship between red pixel and microplastic concentration is consistent. Raman Mapping could be a good measure to quantifying microplastics.

Future

Apply this method to other food matrix such as Powerade, Oil, Chicken etc.

Use this method to study other microplastics such as Polypropylene, Polyvinyl chloride etc.

Acknowledgements

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