Raman signal amplifying membrane filters for nanoplastic research

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Background

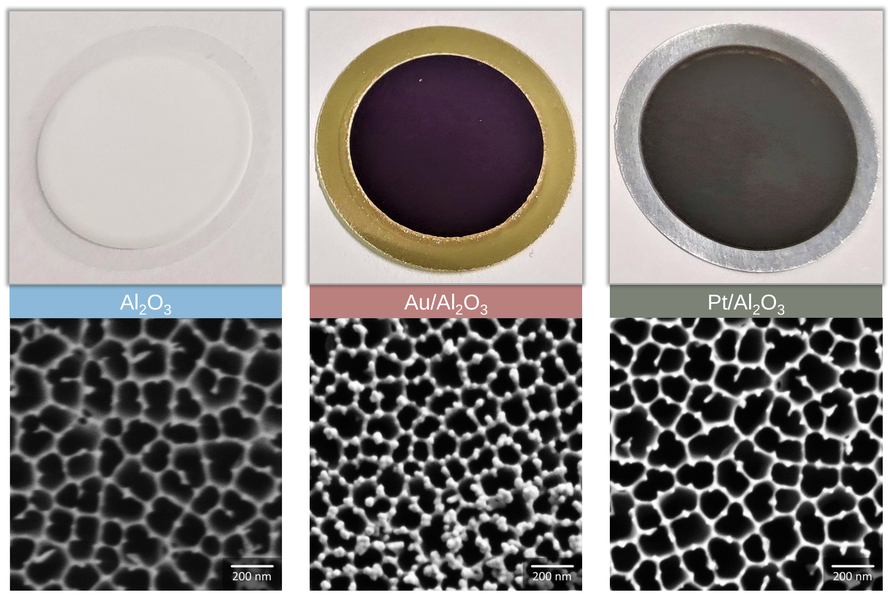
Due to the rapidly increased production of plastic and inadequate waste treatment, more and more plastic ends up in our waters every day. Plastic can degrade to smaller micro- (1 µm – 5 mm) and nanoplastics (< 1 µm) e.g. under mechanical abrasion and UV-light. In addition to the damage of marine life, the small plastic waste has raised concerns regarding to human health. Nanoplastics can enter cells or even penetrate the blood-brain barrier. [1,2]

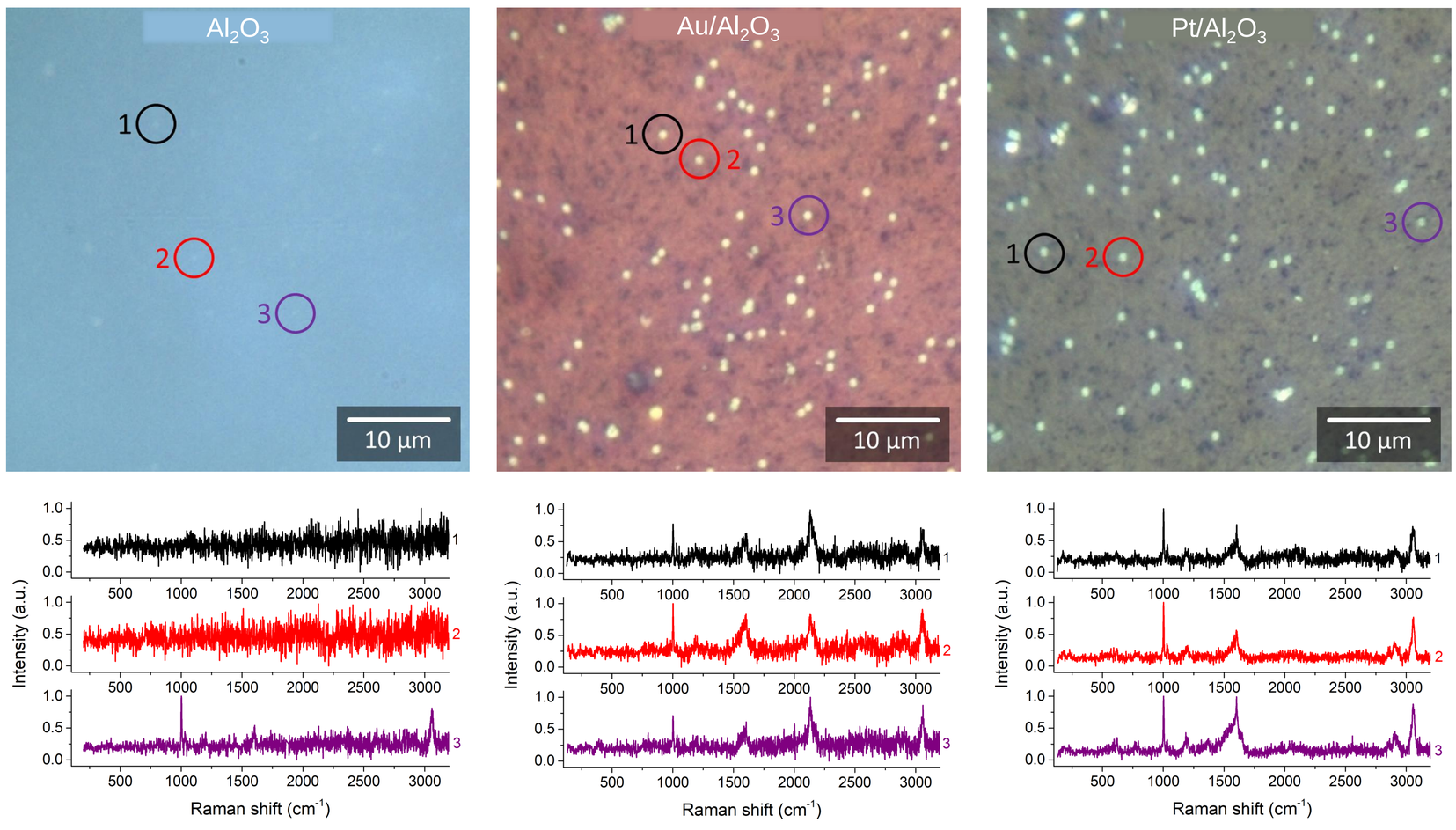
Aim of this work

The main goal of this project is to develop a method, that can be used to image and detect nanoplastics from seawater. In this work we focused on improving the detection of nanoplastics with Raman-microscope by using surface-enhance Raman spectroscopy/scattering (SERS). Also, the sample processing was simplified by using membrane filter as a SERS substrate.

Materials and Methods

Thin layers of gold and platinum were deposited on Al_2O_3 membrane filters (pore size: 200 nm) via sputtering. Scanning electron microscope (SEM) was used to characterize the morphology of the membranes. Polystyrene (PS) spheres (diameter: 500 nm) in aqueous solution was deposited on to these membranes by vacuum filtration. Raman-microscope was used to measure Raman-spectra of 3 individual PS spheres on each membrane.





Results

- PS nanoplastics are more visible against the colored Au and Pt backgrounds in microscopic images.
- Better Raman signal is obtained from PS nanoplastics when the membrane is coated with thin Au or Pt layer.
- Since nanoplastics can be detected directly from the membrane filter, less processing is needed.

References

1. Lim, X., Nature 2021, 593, 22-25.
2. Mandemaker, L. D. B. ja Meirer, F., Angew. Chem. Int. Ed. 2023, 62.

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