Total reflection X-ray fluorescence reference materials for cascade impactor air quality monitoring systems

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The development of traceable methodologies to measure particulate matter concentration and monitor air quality in polluted areas of Europe is an important challenge to be addressed in order to reduce health and environmental backlashes. The use of cascade impactor sampling methods coupled with total reflection X-ray fluorescence (TXRF) spectroscopy for elemental mass concentration measurements is an accurate way with fast response and low level of uncertainty [1]. Certified reference materials are being developed to mimic the cascade impactors patterns with known quantities and distribution of target elements.
To this goal, a new method has been developed to obtain flexible, reusable and low-cost parylene C shadow masks by using photolithographic steps. After the fabrication, the obtained micro stencils are applied to 30 mm acrylic substrates in order to evaporate different metals and thus replicating the Dekati patterns.
Another type of reference samples can be obtained by directing the self-assembly of block copolymers (BCPs) nanotemplates inside pre-lithographed Dekati patterns and by infiltrating the BCPs with metallic oxide. The absolute quantification of infiltrated materials by means of reference-free GIXRF allows tuning the process for the required metallic mass deposition.

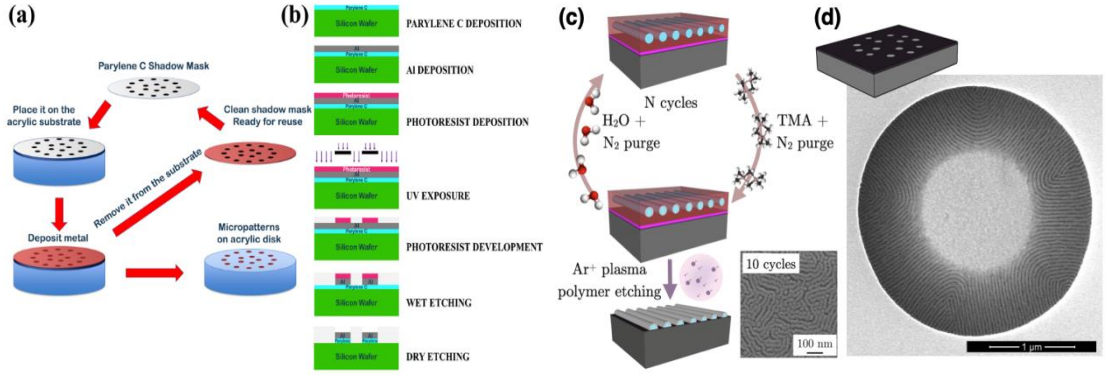

Figure 1. (a) Sequence of steps for micropatterning using reusable parylene C shadow masks and (b) sketch of the fabrication steps used to obtain the parylene C stencils. (c) Scheme of the sequential infiltration synthesis of BCPs cylindrical nanotemplates and SEM image of the resulting metallic oxide replica. (d) Microtemplate on silicon used to direct BCPs' self-assembly in the Dekati pattern.

References

[1] S. Seeger, et al., Quantification of element mass concentrations in ambient aerosols by combination of cascade impactor sampling and mobile total reflection x-ray fluorescence spectroscopy, Atmosphere (Basel). 12 (2021). https://doi.org/10.3390/atmos12030309.