Total Reflection X-ray Fluorescence Reference Materials for Cascade Impactor Air Quality Monitoring Systems

3. Aerosol Metrology. Advanced X-ray Techniques II

3.1. The Role of Aerosol Science on Understanding and Preventing SARS-CoV-2 Transmission in the Community

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The worldwide spread of the SARS-CoV-2 virus is partly due to the fast and unconstrained mechanism or mechanisms of transmission. Infection is usually present in the upper respiratory tract, which is typically the initial site of infection and source of replication for transmission for influenza viruses [1]. Despite the well-known potential for airborne spread of coronavirus disease (COVID-19) the mechanical properties, airborne behaviour, transport, and capture as inhaled micro-nano particles by human subjects present in the same area as the host, has not been adequately recognized. However, there is well documented evidence for the significant potential for inhalation exposure to viruses in microscopic respiratory droplets (aerosol) at short to medium distances (up to several meters, or room scale). Before the current pandemic, airborne infectious disease transmission was found not only to occur by coughing and sneezing, but also during normal speech, which also yields large quantities of particles that are too small to see by eye, but are large enough to carry a variety of communicable respiratory pathogens [2].

This work will demonstrate examples of the aerosol properties governing residence time and transmission in indoor space and explore the use of preventive measures to mitigate this route of airborne transmission. Studies have demonstrated beyond any reasonable doubt that viruses are released during exhalation, talking, and coughing in aerosol particles small enough to remain aloft in air and pose a risk of exposure at distances beyond 1–2 m from an infected individual.

References

1. Lakdawala, S.S.; Jayaraman, A.; Halpin, R.A.; Lamirande, E.W.; Shih, A.; Stockwell, T.; Lin, X.; Simenauer, A.; Hanson, C.T.; Vogel, L.; et al. The soft palate is an important site of adaptation for transmissible influenza viruses. *Nat. Cell Biol.* **2015**, *526*, 122–125. https://doi.org/10.1038/nature15379.
2. Asadi, S.; Wexler, A.S.; Cappa, C.; Barreda, S.; Bouvier, N.M.; Ristenpart, W.D. Aerosol emission and superemission during human speech increase with voice loudness. *Sci. Rep.* **2019**, *9*, 1–10. https://doi.org/10.1038/s41598-019-38808-z.

3.2. Total Reflection X-ray Fluorescence Reference Materials for Cascade Impactor Air Quality Monitoring Systems

(Awarded with the Best Oral Presentation Related to X-ray Spectroscopy by EXSA)

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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 a 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 (Figure 6a), the obtained micro stencils are applied to 30 mm acrylic substrates in order to evaporate different metals and thus replicating the Dekati patterns (Figure 6b).

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 (Figure 6c,d). The absolute quantification of infiltrated materials by means of reference-free GIXRF allows tuning the process for the required metallic mass deposition.

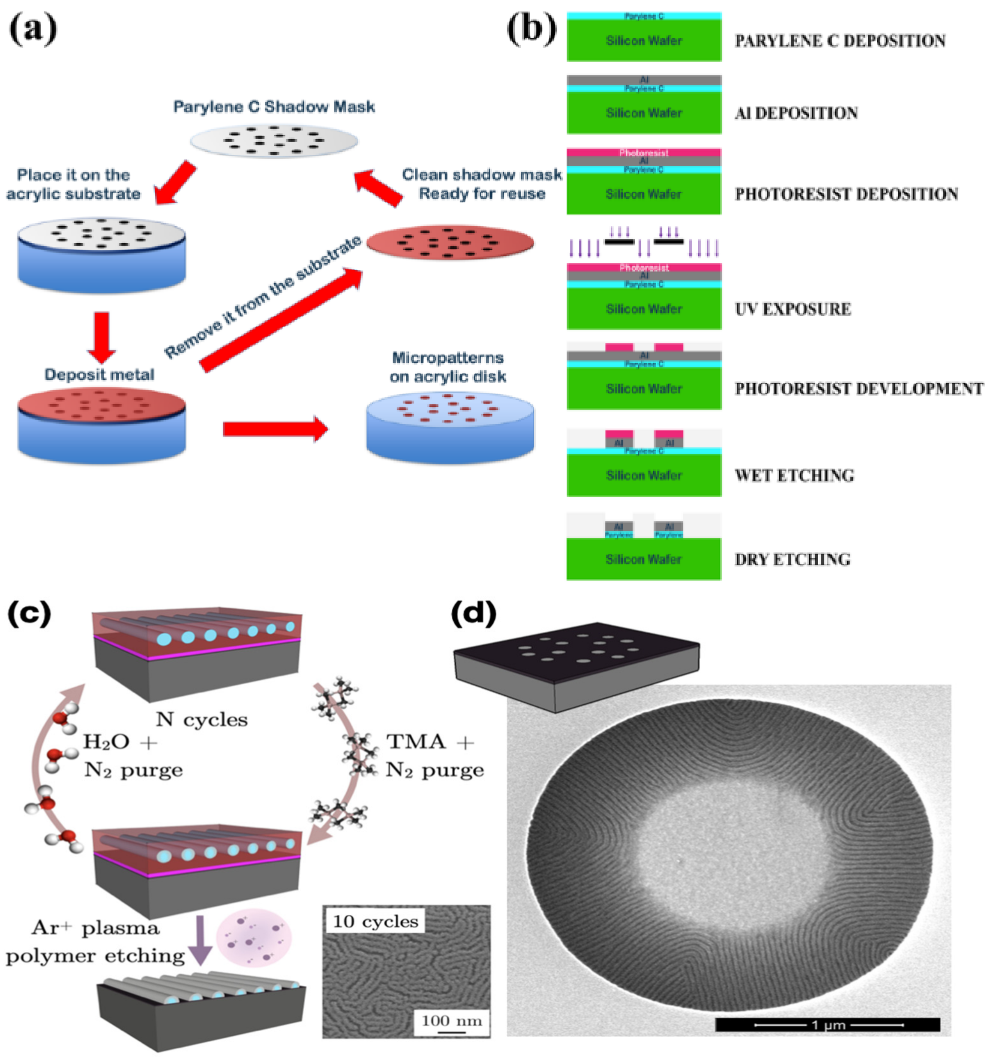

Figure 6. (**a**) Sequence of steps for micropatterning using reusable parylene C shadow masks and (**b**) sketch of the fabrication steps used to obtain the parylene C stencils. (**c**) Scheme of the sequential infiltration synthesis of BCPs cylindrical nanotemplates and SEM image of the resulting metallic oxide replica. (**d**) Microtemplate on silicon used to direct BCPs' self-assembly in the Dekati pattern.

Reference

1. Seeger, S.; Osan, J.; Czömpöly, O.; Gross, A.; Stosnach, H.; Stabile, L.; Ochsenkuehn-Petropoulou, M.; Tsakanika, L.; Lymperopoulou, T.; Goddard, S.; 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* **2021**, *12*, 309.