International research team develops method to characterize nanomaterials

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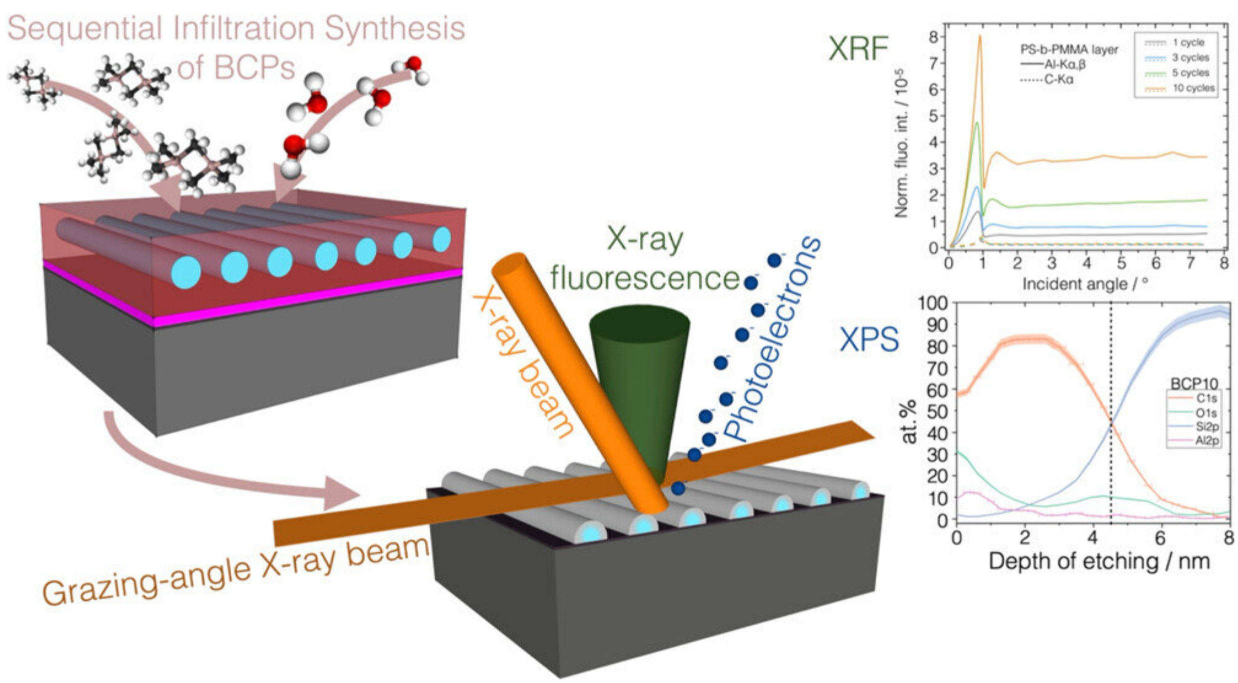

Abstract. The sequential infiltration synthesis (SIS) of inorganic materials in nanostructured block copolymer templates has rapidly progressed in the last few years to develop functional nanomaterials with controllable properties. To assist this rapid evolution, expanding the capabilities of nondestructive methods for quantitative characterization of the materials properties is required. In this paper, we characterize the SIS process on three model polymers with different infiltration profiles through *ex situ* quantification by reference-free grazing incidence X-ray fluorescence. More qualitative depth distribution results were validated by means of X-ray photoelectron spectroscopy and scanning transmission electron microscopy combined with energy-dispersive X-ray spectroscopy. Credit: *ACS Applied Polymer Materials* (2023). DOI:

10.1021/acsapm.2c02094

Researchers from Paderborn University, the Istituto Nazionale di Ricerca Metrologica (INRiM),Italy's national metrology institute, the Politecnico di Torino, Italy, and the Physikalisch-Technische Bundesanstalt (PTB), National Metrology Institute of Germany, have studied sequential infiltration synthesis in nanostructured polymers.

They hope to improve the possibilities for characterizing material properties at the smallest length scale. Materials with structures in the range of just a few nanometers will be essential, for instance, in future computer chips, energy conversion and energy storage processes, and molecular sieves. The researchers have now published their findings as a cover article in *ACS Applied Polymer Materials*.

At Paderborn, the team led by physicist Prof. Jörg Lindner works with nanostructured block copolymers, interlinked polymer chains that "self-organize" into regular patterns, allowing for a wide range of applications.

"Our ability to control the self-organization of block copolymers has made rapid progress in recent years," says Lindner. In order to continue this development, though, nondestructive methods for characterizing material properties must be expanded, as the goal of a larger endeavor involving the co-authors of partner institutions, INRiM, Politecnico di Torino and PTB.

Block copolymers allow extremely small structures to be created on semiconductor surfaces, which facilitates future-oriented processes for further miniaturizing next-generation microelectronic components.

"The structure sizes that can be achieved here are limited only by the length of the polymer chains, so they can be even smaller than the structures that are laboriously produced through conventional techniques. The advances in miniaturization also create a need for new measurement methods and size standards so that smaller structures can be analyzed. Block copolymers can help here, too—but only after the chemical differences between the involved polymer types are increased by selectively modifying one of the polymers. Selectively integrating aluminum oxide using sequential infiltration synthesis makes it possible to create nanostructures that can be used to test these new measurement processes," explains Lindner.

More information: Eleonora Cara et al, Developing Quantitative Nondestructive Characterization of Nanomaterials: A Case Study on Sequential Infiltration Synthesis of Block Copolymers, *ACS Applied Polymer Materials* (2023). DOI: 10.1021/acsapm.2c02094

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