New method to engineer surfaces along multiple directions in a nanowire

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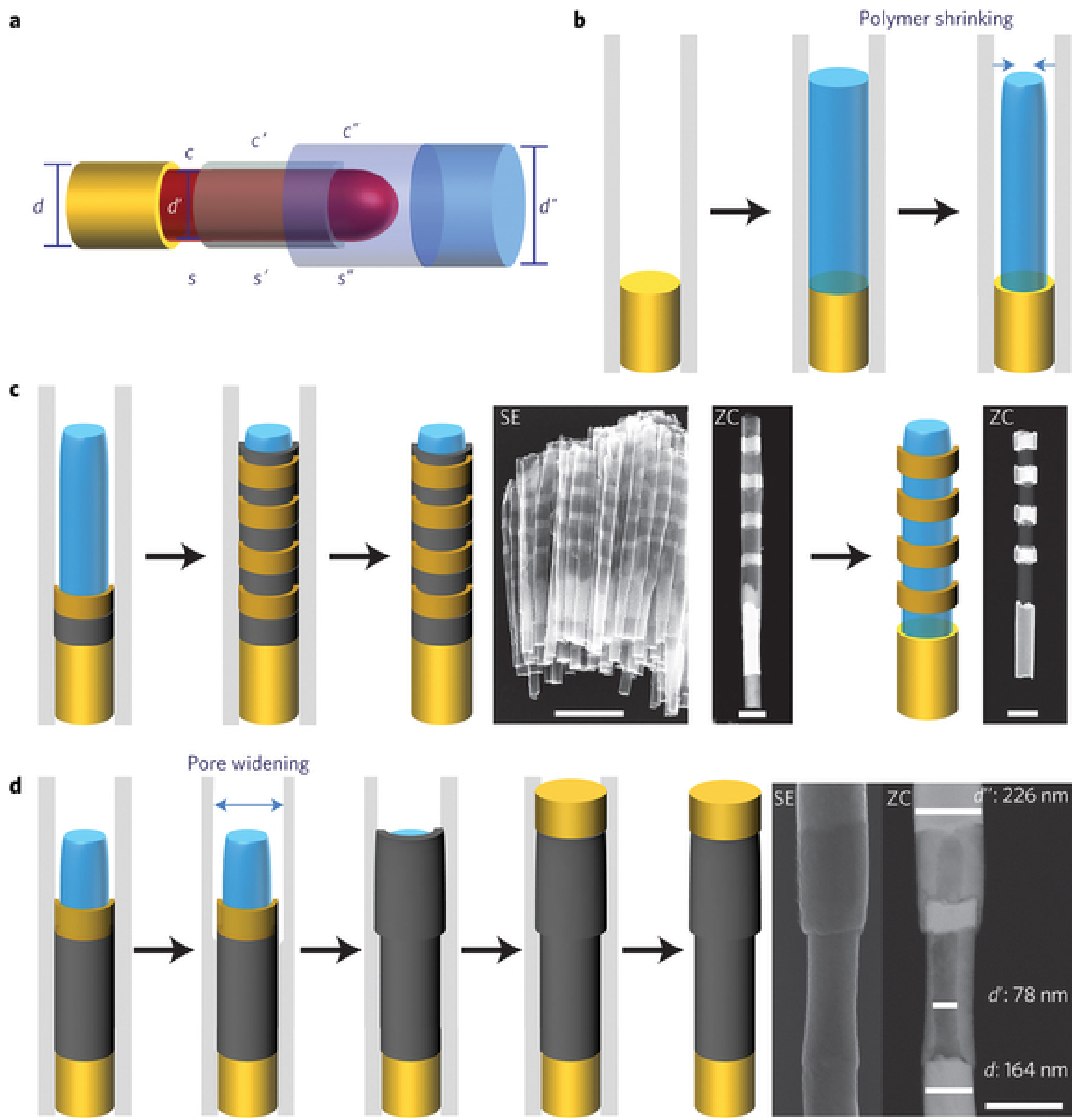

Coaxial lithography. Credit: *Nature Nanotechnology*, 10, 319–324 (2015) doi:10.1038/nnano.2015.33

Nanoscale one-dimensional nanostructures (i.e. nanowires) offer vast opportunities in photovoltaics and photonics due to their exceptional optical and electrical properties, which are entirely tunable by varying their architectures. Unfortunately, current synthetic limitations have hindered the range of studies and devices that can be made with such structures.

In a recent manuscript, published online as a letter in *Nature Nanotechnology*, Northwestern University researchers have found a way to engineer surfaces along multiple directions in a nanowire. This new technique, termed coaxial lithography (COAL), offers a combination of radial and longitudinal degrees of compositional freedom within the nanowire. Synthetic control over the radial dimension combined with the possibility of selectively deleting features used to build the nanowires significantly expands the range of architectures that can be synthesized using COAL.

Professor Chad A. Mirkin, the corresponding author of the paper, said, "COAL allows for the rational design and preparation of nanowires with very complex architectures that cannot be made by any other techniques."

The technique presented in the paper represents a significant advance in nanomaterials synthesis by design because it is applicable to a wide variety of materials such as metals, organic semiconductors, metal oxides and metal chalcogenides.

The integration of plasmonic (metal) nanorings around and within semiconductor nanowires with unprecedented control over their locations and dimensions also was demonstrated in this work. The capacity to integrate these two types of materials into one construct is heavily sought after due to the extraordinary ability of metal nanostructures to enhance light absorption within semiconductors. By controllably embedding a light-concentrating plasmonic nanoring within core/shell semiconductor nanowires, the authors reported significant enhancement in the photodetection capabilities of semiconductor nanowires.

Mirkin's Ph.D. student Tuncay Ozel and postdoctoral researcher Gilles Bourret, equal contributors to the paper, said, "Using our approach, an almost unlimited number of shells can be prepared on the same nanowire. Complete tunability in terms of surface plasmon resonance and electric field by controlling the diameter, length and ring spacing is reported with an unprecedented sub-10 nanometer precision. Both the nanowire and plasmonics communities will find these advances substantial."

Mirkin added, "I believe that COAL will dramatically increase the capabilities of researchers who are interested in studying the chemistry and physics of negative surface materials, interfaces between organic and inorganic materials, and light-matter interactions. This technique allows for the synthesis of materials with architectures unachievable via other means."

More information: "Coaxial lithography" *Nature Nanotechnology* 10, 319–324 (2015) DOI: 10.1038/nnano.2015.33

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