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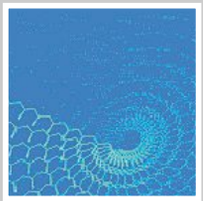

Polymer and Colloid Highlights

Division of Polymers, Colloids and Interfaces
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Colloidal Routes to Macroscopic Monoliths of Porous Titania and Copper

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Nanoparticles with their size and shape-dependent properties are the ideal building blocks for the fabrication of new materials with tailor-made functionalities.[1] However, the assembly of such nanoscale constituents to macroscopic materials requires subtle control over their arrangement in three dimensions and over several orders of length scales.[2]

Based on two examples, this Highlight presents the preparation of macroscopic materials by liquid-phase chemistry using preformed metal oxide particles as building blocks.

In the first case, surface-functionalized titanium dioxide nanoparticles of just a few nanometers in diameter are connected by oriented attachment into a three-dimensional aerogel monolith of macroscopic size (Fig. 1).[3] The gelation of the anatase nanocrystals is guided by the controlled destabilization of the {001} crystal facets. Such aerogels offer a large variety of interesting properties: They are extremely light, fully crystalline, translucent, highly porous, and exhibit a large surface area of about 550 m^2/g.

The use of preformed nanoparticles with defined compositions and properties bears the unique advantage that different types of nanoscale building blocks can be co-assembled, resulting in multicomponent aerogels not accessible by any other technique.[3]

The second example includes the electroless, but catalyst-free deposition of metallic copper, either as freestanding submicrometer-thin foil (Fig. 2a) or supported on a polymer substrate, which then can be processed into a line pattern for flexible electronics (Fig. 2b).[4] Deposition of the copper on spherical ZnO particles as building block/template gives access to copper capsules after removal of the template (Fig. 2c). Compaction and shaping of these capsules finally results in mechanically stable copper foam monoliths (Fig. 2d).[5] Pore size and shape are predetermined by the morphological characteristics of the metal oxide building block acting as template.

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[1] F. J. Heiligtag, M. Niederberger, *Mater. Today* **2013**, *16*, 262.
[2] D. Koziej, A. Lauria, M. Niederberger, *Adv. Mater.* **2014**, *26*, 235.
[3] F. J. Heiligtag, M. D. Rossell, M. J. Süess, M. Niederberger, *J. Mater. Chem.* **2011**, *21*, 16893.
[4] N. Kränzlin, S. Ellenbroek, D. Duran-Martin, M. Niederberger, *Angew. Chem. Int. Ed.* **2012**, *51*, 4743.
[5] N. Kränzlin, M. Niederberger, *Adv. Mater.* **2013**, *25*, 5599.

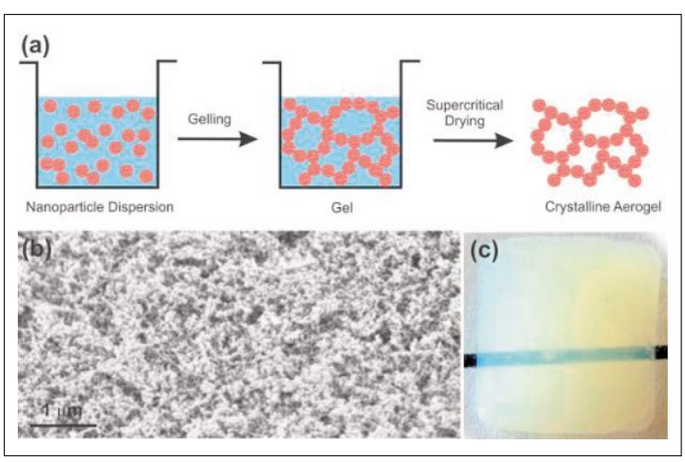

Fig. 1. (a) Scheme for the formation of nanocrystal-based aerogels. (b) SEM image of an anatase aerogel. (c) Photograph of a translucent anatase aerogel monolith.

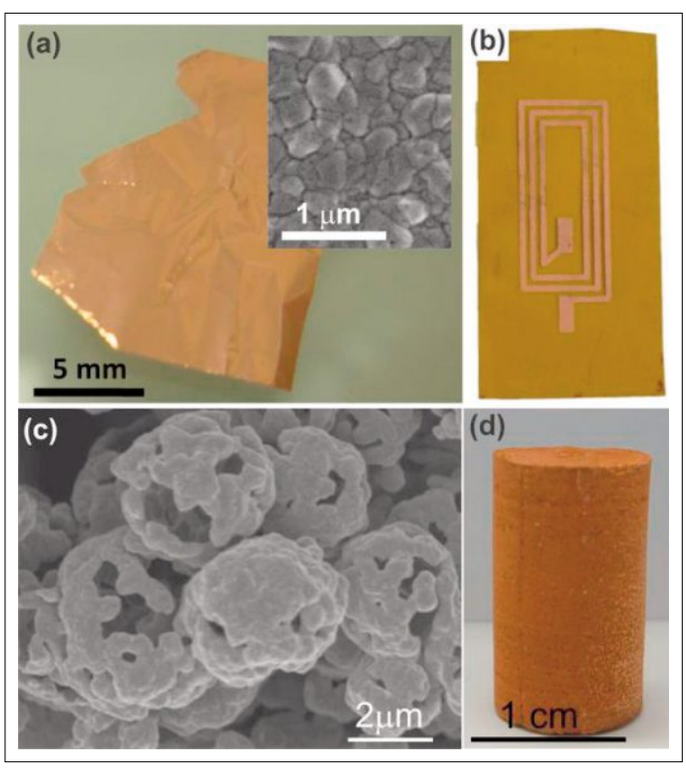

Fig. 2. (a) Photograph of a macroscopic piece of copper foil (inset: SEM image of the dense microstructure). (b) Copper line pattern on Kapton. (c) SEM image of copper capsules. (d) Photograph of a macroscopic body of copper foam.

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