Inorganic colloids now come in many forms — spheres, discs and rods. With the addition of branched tetrapods to this list, the potential for creating materials with interesting mechanical, optical and electrical properties is even greater.
Emerging diversity in nanocrystal and nanowire building blocks. a. Progression of nanocrystal structures from homogenous, to core–shell and elongated structures, to branched tetrapod and multi-branched materials. b. Progression of nanowire structures from uniform wires, to structures modulated in the axial and radial directions, and finally to multi-branched materials. In both sequences, distinct colours are shown to indicate variations in material composition and/or doping.

Looking to the future, it is worth considering adding further structural complexity to the nanocrystal family of building blocks, as well as their relationship to related nanowire structures (Fig. 2). In the case of nanocrystals, these building blocks have evolved from homogeneous, roughly spherical clusters to core–shell clusters and elongated nanorods, and now to the present tetrapods. As Alivisatos and co-workers suggest, it is natural to consider further branching — that is, nucleation of a cubic phase after initial arm elongation followed by another period of arm growth — analogous to organic dendrimers (Fig. 2a). A similar progression has occurred in the structures of nanowire building blocks, which typically have higher length/diameter ratios than elongated nanocrystals. In just the past year, nanowires have developed from uniform structures, to ones with composition and/or doping modulated along the axial and radial directions, and even towards the first signs of branched structures (Fig. 2b), albeit lacking the control of this new nanocrystal work. It is interesting to see that the branched structures of both nanocrystals and nanowires are converging to a very similar point, and we also recognize that enhanced knowledge of fundamental factors controlling growth has been crucial to the advances in structural complexity in these two areas.

Are such branched nanostructures the limit we can achieve by rational synthesis? We think the future holds the potential for much greater complexity and that this may drive some of the most unique and exciting applications possible from the bottom-up approach to nanotechnology. For example, consider further the case of multi-branched nanocrystal and nanowire structures (Fig. 2). In researchers extend the work of Alivisatos and co-workers to enable sequential branching with variations in the composition and/or doping, it will be possible to introduce novel electronic and photonic functionality into these building blocks. Returning to the analogy with biology, such multi-branched structures might serve as building blocks for three-dimensionally interconnected computing structures, not unlike the neural connections found in the brain.

References