Study: New nanomanufacturing processes needed

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If the promise of nanotechnology is to be fulfilled, then research programs must leapfrog to new nanomanufacturing processes. That's the conclusion of a review of the current state of nanoscience and nanotechnology to be published in the *International Journal of Nanomanufacturing.*

Khershed Cooper of the Materials Science and Technology Division, at the Naval Research Laboratory, in Washington, DC and Ralph Wachter of the Division of Computer and Network Systems, at the National Science Foundation, in Arlington, Virginia, USA, explain how research in nanoscience and the emerging applications in nanotechnology have led to new understanding of the properties of matter as well producing many novel materials, structures and devices.

Indeed, the list of possible applications of nanotechnology continues to grow: water filtration and purification, engineered composite materials with modified mechanical properties controlled electrical behaviour and corrosion resistance. There are nano-based materials being used as sealants, anti-fogging and abrasion resistant coatings for glass and other materials, conductive resins, paints and electromagnetic shielding as well as sensors, self-healing materials, super-hydrophobic surfaces, solar cells and ultracapacitors for energy storage as well as materials for armour and protection against bullets and bombs.

The team's own research has focused on developing tools and techniques to make scalable processes for nanomanufacturing. They are

investigating massively parallel techniques, masks and maskless processes for making 3D structures with nanoscopic features. However, they also suggest that several obstacles must be surmounted for nanotechnology to thrive as a future industrial endeavour. In particular, the team believes that research and development should be directed in the following areas:

- Multi-scale design, modelling and simulation of nanosystems.
- Component integration within large-scale systems.
- Integration across physical scales.
- Qualification, certification, verification and validation.
- Cyber-enabled manufacturing systems.

"Looking ahead, nanotechnology is slated to move into complex, multi-functional, multi-component nanosystems, e.g., nano-machines and nano-robots," the team concludes. "These nanosystems will be adaptive, responsive to external stimuli, biomimetic, intelligent, smart and autonomous. Nanomanufacturing R&D will be needed to develop the knowledge base for the reliable production of these complex nanosystems."

More information: "Nanomanufacturing: path to implementing nanotechnology" in *Int. J. Nanomanufacturing*, 2013, 9, 540-554

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