material. Only well-ordered supra-crystals showed coherence between the atomic-scale lattice vibrations of the constituent silver nanoparticles, whereas in less-ordered materials the particles vibrated independently of each other. This means that the particles behave as a true ensemble if they are organized within a supra-crystal. Their atomic lattices vibrate coherently, which is equivalent to the appearance of vibrational modes in the lattice of the 3D supra-crystal.

The importance of this discovery is that it establishes for the first time the emergence of a new collective property in 3D supra-crystals. It has now been demonstrated that these new materials are not only statically highly ordered on the nanometre scale, but also exhibit an intrinsic dynamic behaviour (lattice vibrations) that is absent in non-crystalline solids composed of nanoparticles. What are the practical consequences of this development? Solid-state materials composed of nanoparticles or quantum dots are considered for a range of advanced applications including sensors and information-storage devices. Understanding their dynamic behaviour is clearly of paramount importance for our ability to manipulate and optimize their function. For example, electronic transport across supra-crystals will be influenced greatly by lattice vibrations so that large differences in conductance can be expected between 'in' and 'out of' resonance transport. Introducing lattice defects by implanting particles of a different material or size could thus create opportunities for localized charge storage, which could be made reversible under certain resonance conditions.

As the authors suggest, a new research area in materials science is now open, even though the future success of this field will still depend on improving our ability to produce uniform nanoparticles and to coax them into the formation of high-quality 3D supra-crystals. If these chemistry-related issues can be resolved, then the full potential of the collective properties of supra-crystals — of which the authors have caught the first glimpse — could be significant indeed.

References

1. Murray, C. B., Kagan, C. R. & Bawendi, M. G. Self-organization of CdSe nanocrystallites into three-dimensional quantum dot superlattices. Science 270, 1335–1338 (1995).
2. Whetten, R. L. et al. Nanocrystal gold molecules. Adv. Mater. 8, 428–231 (1996).
3. Courty, A., Mermet, A., Albouy, P. A., Duval, E. & Pileni, M. P. Vibrational coherence of self-organized silver nanocrystals in f.c.c. supra-crystals. Nature Mater. 4, 395–398 (2005).
4. Collier, C. P., Saykally, R. J., Shiang, J. J., Henrichs, S. E. & Heath, J. R. Reversible tuning of silver quantum dot monolayers through the metal-insulator transition. Science 277, 1978–1981 (1997).
5. Markovich, G. et al. Architectonic quantum dot solids. Acc. Chem. Res. 32, 415–423 (1999).
6. Quinn, B. M., Prieto, I., Haram, S. K. & Bard, A. J. Electrochemical observation of a metal/insulator transition by scanning electrochemical microscopy. J. Phys. Chem. B 105, 7474–7476 (2001).
7. Weitz, I. S., Sample, J. L., Ries, R., Spain, E. M. & Heath, J. R. Josephson coupled quantum dot artificial solids. J. Phys. Chem. B 104, 4288–4291 (2000).

MATERIAL WITNESS

Fab DIY

Fixing the bathroom sink has persuaded me of the merits of personal fabrication. It was a Sunday evening, and I could not reconnect the water supply until I'd fitted two old taps with non-standard pipe gauges. With the tools described in Neil Gershenfeld's new book *Fab* (Basic Books, New York, published in April 2005), I could have created a customized adapter from metal tubing.

Personal fabrication, says Gershenfeld, of MIT's Media Lab, is about making "anything you want" for a market of one. He describes how his team has put together desktop fabrication systems that cost around $20,000, incorporating cutting tools such as lasers and jets of abrasives as well as additive tools such as three-dimensional printers that create objects layer by layer from fusable powder. These devices are linked to computerized design tools, and are integrated with standard microprocessor components for making controllers and sensors.

A system like this is hardly within the means of ordinary consumers, but it is a lot more amenable than an industrial factory, and more versatile too. And Gershenfeld claims that the current models are just bridging systems, the equivalent of the microcomputers that paved the way from mainframes to the PC. He says that in 10–20 years the computer and printer on your desk will be accompanied by a personal fabricator, at a comparable cost.

His goal is to produce fabricators that work digitally, with microscopic building blocks that can be assembled accurately and reversibly. Digital assembly, he says, gives the same kind of error tolerance that digital logic brings to information technology.

The most inspiring aspect of *Fab*, however, is that it presents a vision of personal fabrication that is not simply about creating a lucrative new consumer market. Once they had working prototypes of the desktop system, Gershenfeld and his colleagues took them not to venture capitalists but to Ghana, India, to remote Norway and inner-city Boston, to discover how people in developing countries and under-resourced communities would respond to the chance to make (almost) anything.

Valuable and imaginative ideas began to emerge at once. Developing countries, says Gershenfeld, have no lack of expertise and initiative; no extensive training is needed to put the technology to use. What they lack is the physical means to convert needs to solutions — and that is what personal fab offers. Whether it was milk-analysing meters or radio monitors for wandering sheep, the desktop fablabs could address highly individualized needs in a way that mainstream industry never will. Even inner-city children somehow found their way to making inventive devices.

Gershenfeld says that the implications of personal fab go still deeper. He thinks that an open-source ethos for disseminating design solutions, combined with the possibilities that the technology offers for investigating how things work, could take science itself out of the institutions such as MIT and into the hands of a community that currently lacks the means to explore and experiment.

I fixed the sink, by the way, but the details were painful and messy. Get me a personal fablab.

Philip Ball