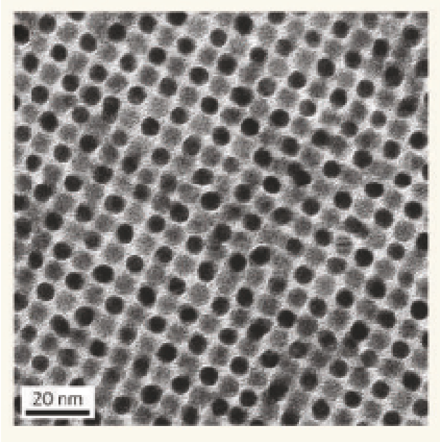

Figure 1 | Binary diversity. Urban *et al.*[1] build on work that has generated a huge variety of binary nanoparticle superlattices incorporating semiconducting, metallic and magnetic building-blocks: here, semiconducting lead selenide (lighter particles) is ordered in a lattice with metallic gold nanoparticles. (Reproduced from ref. 8.)

kind of superlattice embedded in a thin film of a different composition[4]. The dots exhibit size-dependent quantum effects that allow their thermopower to be optimized independently of the thin film[5]. With all these materials, however, there is a significant caveat: they have so far been produced on very small scales, using highly specialized tools. Scaling up such preparations to produce bulk materials remains a daunting challenge.

This is where the binary nanocrystal superlattices exploited by Urban *et al.*[1] come in. A basic nanocrystal superlattice is essentially a 'crystal of crystals' — a regular crystalline array in which the individual components are themselves spherical, chemically synthesized nanoscale crystals consisting of a few hundred to tens of thousands of individual atoms[6]. Binary nanocrystal superlattices follow the same principles, but are formed by the co-crystallization of two different sets of nanocrystals. They could thus potentially combine the desirable attributes of both sets, while also providing a route to a material that can be manufactured on a larger scale.

Two barriers must be overcome. First, binary nanocrystal superlattices are largely limited to a few tightly packed crystal structures, such as those found in naturally occurring opals[7]. That limits their versatility in applications. Second, large 'capping' molecules are required to stabilize the nanocrystal surfaces, preventing them from interacting strongly with each other. Such isolation means that, even if individual physical parameters are optimized in each of the nanocrystal types in the superlattice, the collective properties of the superlattice would be less than the sum of its parts.

These barriers have recently begun to crumble. Many different binary superlattices, including several new crystal structures, have been generated[8] in the past couple of years using ionic interactions[9] between nanoparticles (Fig. 1). That has not only made for fascinating crystallography, but has also dramatically expanded the tool-kit for materials design. This assault on the first obstacle to progress is now followed by Urban and colleagues' offensive[1] on the second. They have made the first binary lattices that show synergistic effects arising from the interactions of separately optimized nanoparticles.

With an eye towards thermoelectric capability, the authors chose lead telluride (PbTe) and silver telluride (Ag_2Te) as their nanocrystal building-blocks. Bulk PbTe has a high thermopower, in that it generates a large voltage from a small heat flow. The addition of Ag_2Te provides silver ions as dopants, thus improving the material's overall electrical conductivity, and so its thermoelectric figure of merit.

The authors prepared two types of binary lattice with differing levels of Ag_2Te dopant. In a later stage, they also replaced the capping molecules that stabilize the nanocrystals in the superlattices with the much smaller molecule hydrazine (N_2H_4). The effect of this second process is to compress the binary lattice so that the individual nanocrystals are in close contact. Although the values for the thermoelectric figure of merit are not reported, the electrical conductivity of the treated binary superlattices was approximately 100 times greater than that of similarly treated superlattices of the individual components. This represents convincing evidence of a property of the bulk solid arising from the collective interactions of its nanocrystal components.

Such multicomponent superlattice approaches to materials design are still in the early stages of development. The generation of truly high-performance materials, requiring the optimization of many competing parameters, is still some way off. Farther away still is proof that these approaches can be scaled up to produce materials for industrial applications. Advances are coming thick and fast, however. With the kind of progress exemplified by Urban and colleagues' work[1], the limited tool-kit for materials engineering is expanding into a treasure trove of resources. ■

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50 & 100 YEARS AGO

50 YEARS AGO

Atomic Quest: A Personal Narrative. By Dr. Arthur Holly Compton. — Prof. Compton describes in great detail the agonizing discussions which went on among the scientists of the Metallurgical Laboratory and Los Alamos during 1945 as to whether the bomb should be used against the Japanese. The discussions were brought to the attention of the Secretary of State for War, Mr. Stimson, who appointed a representative 'Interim Committee' to advise him. At this point General Marshall stated that he would advise against its use in the war provided its existence could be kept secret. The general opinion was, however, that it would not be possible to keep its existence secret. A proposal to make a non-military demonstration likely to bring an end to the war was also thought to be impossible. After this, a poll of a hundred scientists of the Metallurgical Laboratory brought an 87 per cent vote in favour of its military use. The decision was taken by President Truman on the advice of Mr. Stimson... Prof. Compton believes that the use of the bomb saved a very large number of lives, since he does not believe that the Japanese would have surrendered without bitter fighting in the next landings. **J. D. Cockcroft**

From *Nature* 2 February 1957.

100 YEARS AGO

Dr. Alfred Russel Wallace, in an article entitled "Creation by Law," contributing to the *Quarterly Journal of Science* in October, 1867, alluded to a Madagascar orchis (*Angraecum sesquipedale*) with a nectary varying in length from 10 inches to 14 inches, and prophesied that a hawk-moth will be discovered with a tongue of equal length to fertilise it... Will someone kindly tell me if this prophecy had been fulfilled? **E. W. Swanton**

I have not heard of any moth from Madagascar with an exceptionally long proboscis. I think, however, I did hear of one from East Africa with a proboscis nearly the length required. **Alfred Russel Wallace**

From *Nature* 31 January 1907.