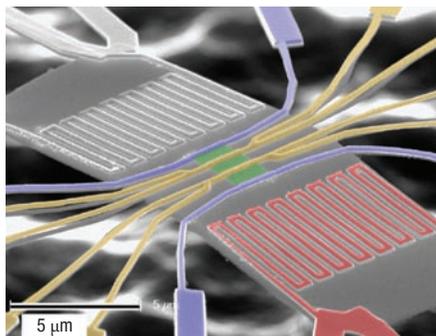


## Thermoelectric wires



*Nature* **451**, 163–167; 168–171 (2008)  
 Converting wasted heat into electrical energy is certainly appealing, which explains the interest in developing more and more efficient thermoelectric devices. The trouble with thermoelectric materials, however, is that their efficiency is optimized by maximizing the electrical conductivity while minimizing the thermal conductivity, which is quite challenging considering that the two parameters are usually interdependent. Two groups have now demonstrated very high thermoelectric efficiency in arrays of silicon nanowires. Both groups exploited the fact that electrons can travel without scattering for distances around 1–10 nm at room temperature, whereas for phonons the distance is around 300 nm. By using wires with diameters lying somewhere between these characteristic lengths they succeeded in reducing the thermal conductivity by two orders of magnitude, while keeping the electrical conductivity unchanged. The efficiency obtained at room temperature is close to that of the highest efficient complex thermoelectrics, but nanowires can be easily scaled up, which makes the results a real breakthrough towards the large-scale production of efficient room-temperature thermoelectric devices.

## Molecular shuttles

*Nano Lett.* **8**, 221–226 (2008)  
 Mimicking nature to create nanoscale machines and combining them to produce larger structures is no mean feat. Moreover, controlling the dynamics and activation of specific nanomachines is proving even more challenging. Henry Hess and colleagues propose a biomimetic approach to dynamically control motor-protein-driven devices. These molecular shuttles consist of a surface patterned with stationary kinesin motors and cargo-binding microtubules transported by the motors. Localized release and enzymatic sequestration of the ATP substrate creates a concentration profile that results in controlled activation of the

molecular shuttles. The activation of these kinesin-driven molecules is triggered by photolysis of caged-ATP in a solution of hexokinase within minutes and without localization. Overall, these findings demonstrate that although activation can be constrained by rapid sequestration and local release, these nanoscale machines are better used as part of disperse swarms rather than individually. The authors say that their approach could represent a step forward for transferring the cellular control strategies of molecular activation to biotechnologies such as computing and bio-inspired logistics.

## Microgels in motion

*Angew. Chemie Int. Ed.*  
 doi: 10.1002/anie.200703953 (2007)  
 Stimulus-sensitive hydrogels swell and contract in response to numerous changes, such as pH, temperature or light. Bulk gels have also been made to ‘self-oscillate’, swelling and contracting as a result of a periodic reaction, such as that of Belousov–Zhabotinsky. The reaction promotes the fluctuation of the redox state of a ruthenium complex between Ru<sup>III</sup> and Ru<sup>II</sup>, and the change in redox state affects the gel’s hydrophilicity, causing it to swell or contract. Yoshida and colleagues have furthered the usefulness of this approach by applying it to microgels — colloidal particles with diameters of a few hundred nanometres made from a copolymer containing a ruthenium complex monomer. They found that when the polymer was swollen with the ruthenium in its oxidized state, the colloid

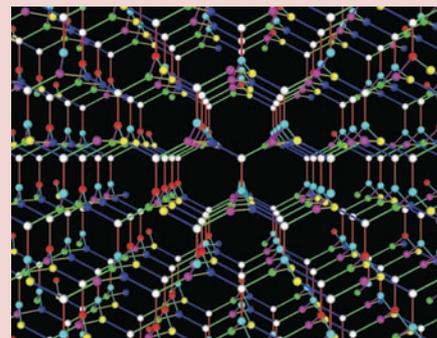
was well-dispersed. When the ruthenium was reduced, however, the gel contracted and became colloidally unstable. This led to flocculation of the gels, and the phenomenon was followed using optical transmittance measurements. With oscillations on the order of tens of seconds, the researchers predict drug release and rheological applications.

## Antiplatelet coating

*J. Am. Chem. Soc.* doi:10.1021/ja0775927 (2008)  
 A device implanted in the body can have a side effect of thrombosis owing to the adhesion of blood platelets to its surface. There has been much research on making the surfaces protein-resistant to minimize the likelihood of this occurring. One common method is to use polyethylene glycol (PEG) bound to the surface. For PEG to be effective, however, it has to have sufficient space for its hydrated form to coil into a helix, but not so much space that the packing density is too low to be protein-resistant; however, controlling the amount that is absorbed has proven difficult. Now Marchant, Rowan and colleagues have developed a tunable supramolecular scaffold to support the PEG on the surface. The scaffold is formed of low-molecular-weight alkane monomers, with binding sites at either end — one end absorbs to the surface, and the other to a PEG molecule. The resulting self-assembled coating was stable at biologically relevant temperatures, and resistant to the binding of platelets. The approach was found to work on various hydrophobic surfaces, with the potential for a range of applications.

## Perfect as diamond

*Not. Am. Math. Soc.* **55**, 208–215 (2008)  
 Diamonds are perfect. Their symmetric crystal lattice and the strong bonds between the carbon atoms make them the hardest known material. When polished, a diamond’s reflecting behaviour captures the imagination. Their symmetry has now been analysed by Toshikazu Sunada, who uses the structural principles of the diamond lattice to propose a related crystal structure with equal mathematical symmetry. A look at the three-dimensional diamond lattice reveals hexagonal rings that appear in the projection of the tetragonally bonded carbon atoms. Sunada’s analysis has now revealed that a more basic structure, termed  $K_4$  crystal, previously described in the context of coordination frameworks, also possesses strong symmetry. The atoms of this crystal are not tetragonally but triangularly



bonded, having an atom in the centre of an equilateral triangle. Unlike diamond, the space-filling crystal constructed from this base unit is chiral, and shows decagonal rings in projection. The close relation of this structure to diamond and its intrinsic symmetry might be interesting for the design of new materials.