research highlights

Wrapping patterns

Phys. Rev. Lett. **106,** 174301 (2011)

© 2011 APS

A piece of paper wrapped around a ball will wrinkle, whereas a rubber sheet achieves full contact and avoids wrinkling. Clearly, amid the non-deformed (single-point contact) and fully wrapped (complete contact) situations, a number of contact patterns can occur. Jérémy Hure and colleagues have now observed disk-, strip- and branch-shaped contact patterns, by wrapping rigid spheres with thin films of various elastic materials coated with a liquid that wets the spheres. They found that the patterns can be predicted by two dimensionless parameters: a measure of the ratio of adhesion and bending energies, R/L_{ec}, with R being the sphere's radius and L_{ec} the film's elastocapillary length — equivalent to the minimum R for which spontaneous wrapping occurs — and a measure of the ratio of adhesion and stretching energies, L/ξ, where L is the film's radius and ξ scales with the size of the largest circle that can be inscribed in the contact area. Because L_{ec} and ξ depend on geometric and material parameters, determination of the material properties of elastic thin films should be possible from the analysis of contact patterns.

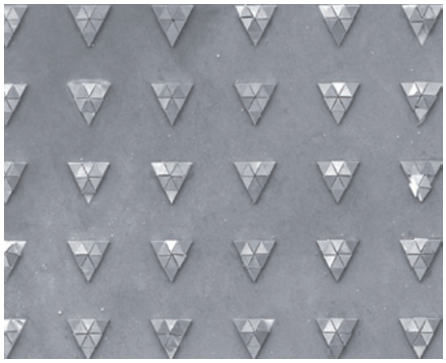
Light therapy

Nature **472,** 334–338 (2011)

Mending cracks within amorphous polymers is most commonly achieved by heating the material above its glass transition temperature. However, this method is generally slow and unreliable as it requires the diffusion and re-entanglement of polymer chains. The rates of these processes are inversely proportional to the polymers' molecular weight, so if the molecular weight could be reversibly decreased this could allow quicker and more efficient healing of the material. By exploiting the non-covalent links within a metal-containing supramolecular polymer, Mark Burnworth and colleagues have now developed such a material that is shown to rapidly heal cracks on exposure to ultraviolet light. Under these conditions, the metal-ligand motifs in the polymer are electronically excited and light energy is converted to heat. As a result, the metal-ligand motifs unlink, decreasing the molecular weight and viscosity of the polymer and allowing rapid photothermal healing of the crack. Using light as a stimulus also brings practical advantages compared with direct heating methods, because localized irradiation, only on the site of the crack, is possible.

Mosaic masters

Adv. Mater. doi: 10.1002/adma.201004533 (2011)



© 2011 WILEY

Stretchable electronic devices that can conform to almost any surface structure enable a considerable range of new applications that are impossible to achieve with conventional brittle designs. One approach to realize such structural advantages, while maintaining the good properties of brittle semiconductors such as silicon, is to assemble small tiles of these on a stretchable substrate. Robert J. Knuesel and Heiko O. Jacobs from the University of Minnesota have now developed a fast self-assembly technique that is capable of placing more than ten thousand tiles per minute on almost any substrate. First, a dense layer of tiles is pre-assembled at the interface of a water and oil film. This is done by coating them with either a hydrophobic or hydrophilic layer, depending on the properties of the tile material itself. A substrate is then pulled through the tiles. At predefined locations the substrate is coated with a solder material, so that the tiles attach at desired locations. The bonded tiles are tightly packed and connect electrically. The versatility of this approach is demonstrated by the fabrication of a fault-tolerant solar-cell module, and a far greater variety of devices seems possible.

Moving the frontier

ACS Nano doi:10.1021/nn2001454 (2011)

The local composition of semiconductor nanorods can be tuned chemically to form heterojunctions, which could be exploited in diodes or solar cells. The fabrication of functional devices requires that a single rod or arrays of nanorods be contacted electrically. However, identifying and accessing individual rods is impractical, and it is difficult to achieve uniform orientation in assembled arrays of heterojunction nanorods. Jessy Rivest and colleagues now report that such ensemble-based devices can be fabricated by first depositing a vertically oriented array of rods from only one material, CdS, on a rigid substrate. Using cation exchange in solution, the researchers then locally converted the material to Cu_2S, starting from the top of the rods. Electrical measurements show that the electrical characteristics of their devices change from ohmic to rectifying during heterojunction formation, and that they show photovoltaic behaviour. At present, the nanorod arrays still have to be contacted with a soft metallic top electrode to prevent structural damage. With further optimization, however, the method may enable the easy fabrication of nanorod heterojunction devices from a range of compounds.

What a drag

Phys Rev. Lett. **106,** 186601 (2011)

The spin-Seebeck effect, which was experimentally observed only three years ago, is the spin redistribution in a crystal due to the application of a thermal gradient. It raised considerable interest, especially after it was observed in ferromagnetic metals, semiconductors and insulators. There is much debate on the mechanism behind the effect. For example, the spin redistributes on length scales that are too large to be due to spin diffusion. Chris Jaworski and colleagues have investigated the issue with extensive experiments on the thermal properties of GaMnAs as a function of temperature. They found a temperature dependence of the spin-Seebeck effect similar to that of the thermal conductivity and to the phonon (lattice excitations) contribution to the standard thermopower in GaMnAs. These observations are fully consistent with a mechanism involving phonon and magnon (collective spin excitations) drag, which was previously suggested theoretically. The insight provided by these experiments could be very important for the development of new conceptual devices coupling spins with phonons.