BLACK PHOSPHORUS

Undercover operation

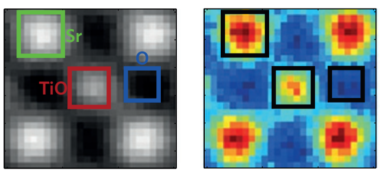
Nano Lett. http://doi.org/xfm (2014)

The recent discovery of high charge-carrier mobility and good switching behaviour in transistors based on few layers of black phosphorus has focused attention on this two-dimensional semiconductor. However, bulk black phosphorus is known to have poor ambient stability, because it forms pits and bubbles on its surface when exposed to oxygen. Joshua Wood and colleagues have now characterized the morphological and compositional evolution of few-layer flakes of black phosphorus exposed to ambient conditions, and observed that oxidized phosphorus species are created within one day. However, if the flakes are covered with a thin layer of aluminium oxide the degradation process is retarded significantly. Transistors encapsulated with this oxide preserve high mobility and good operation as switches for more than one week. The researchers suggest that the conformal coating obtained with atomic layer deposition is the key to prevent the formation of detrimental oxygenated species both at the edges and on the top surface of the flakes. *LM*

ELECTRON MICROSCOPY

Imaging phonons

Ultramicroscopy **147,** 1–7 (2014)



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The energy absorbed or emitted by a phonon excitation is conventionally probed by spectroscopic techniques, such as infrared and Raman, or, more recently, by high-resolution electron energy-loss spectroscopy. The possibility of mapping phonon excitations in a lattice directly in real space has recently been theoretically demonstrated by Christian Dwyer (*Phys. Rev. B* **89,** 054103; 2014), and now demonstrated experimentally by Ricardo Egoavil and co-workers at the University of Antwerp. By acquiring high-resolution spectrum images of a strontium titanate crystal and comparing the differences in electron energy-loss and energy-gain spectral signals around the elastically scattered peak of electrons transmitted by strontium, titanium and oxygen atoms, direct maps of multi-phonon excitations with atomic resolution were obtained. Resolving multi-phonon excitations with such high spatial resolution demonstrates that (differently to what happens for electronic transitions at low energy losses) due to the difference in mass between the fast beam-electrons and the lattice atoms, there is strong localization of the scattering of phonon excitations, allowing for atomic-resolution imaging of phonons. *ON*

THERANOSTICS

Biogenic delivery

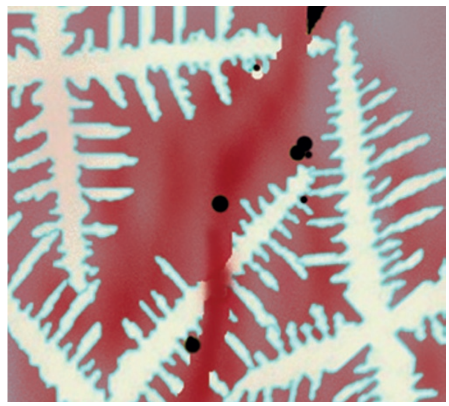
Angew. Chem. Int. Ed. http://dx.doi.org/10.1002/anie201410223 (2014)

Cell-derived microvesicles — spherical fragments formed by budding of the plasma membranes of cells — are known to be pivotal in intracellular communication and have also been investigated as siRNA delivery vehicles. However, the long-term labelling and *in vitro* and *in vivo* tracing of microvesicles remains a challenge and may offer useful information about their biological behaviour. Now, Dai-Wen Pang, Yi-Fang Zhao and colleagues report the efficient and specific labelling of cell-derived microvesicles with quantum dots, enabling them to be traced while maintaining their structure and function. The biocompatible labelling strategy relies on the formation of biotinylated microvesicles that have been shed from cells with biotinylated membranes. These microvesicles are then functionalized with streptavidin-conjugated quantum dots. The delivery of therapeutic siRNA quantum dot-labelled microvesicles derived from endothelial cells was found to reduce tumour size in an *in vivo* mouse xenograft model as a consequence of their observed uptake into tumour and angiogenic vascular cells. The labelling technique could also be successfully applied to macrophage-derived and tumour-derived microvesicles. *AS*

SOLIDIFICATION

Homogenized steel

Nature Commun. **5,** 5572 (2014)



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Segregation during the solidification of steel is the process by which chemical gradients are frozen into a casting. Channel segregates — linear regions of chemical inhomogeneity — are particularly undesirable as they present substantial challenges during subsequent processing of an ingot. Now, Dianzhong Li and colleagues identify oxide-based inclusions, which experience a buoyancy force in the melt, as being key to controlling channel segregate formation. By casting steel under conditions to control oxygen content, they find that channel segregates are supressed in ingots with lower oxygen concentration, reducing the size and number of Al_2O_3 inclusions. Simulations reveal that the inclusions experience a buoyancy force in the melt, the extent of which is dependent on their size; inclusions with a diameter of ~5–30 μm alter melt flow around dendrite arms, destabilizing the mushy zone and promoting the formation of channel segregates. To validate their findings, the authors cast 100-tonne steel ingots in low oxygen conditions, resulting in the almost complete elimination of channel segregates. *JP*

COLLOIDAL GLASSES

Sheared into two flows

Phys. Rev. Lett. **113,** 208301 (2014)

Shear banding — the localization of deformations in bands — is common to metallic, polymer and colloidal glasses. But how such shear inhomogeneities are related to the glasses' microscopic structure and dynamics remains unclear. In atomic and molecular glasses, structural and dynamical changes at the atomic scale are difficult to observe, even by state-of-the-art electron microscopy; however, in colloidal systems the long time trajectories of individual colloids can be easily tracked. Indeed, by using confocal microscopy, Peter Schall and colleagues have been able to investigate the microscopic underpinnings of shear banding in a model colloidal glass. In previous work, they had shown that the non-monotonic flow curves associated with shear inhomogeneities relates to the local structure of the colloidal glass. Now, the researchers found that above a certain critical shear rate, the glass separates into two coexisting steady states with different diffusion timescales, and that such phase separation is analogous to the first-order transition between two phases in equilibrium. It would not be surprising if such a dynamic transition occurs in metallic glasses as well. *PP*

Written by Luigi Martiradonna, Olivia Nicoletti, Pep Pàmies, John Plummer and Alison Stoddart.