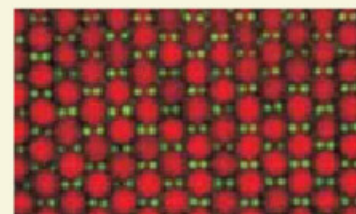


## PHYSICAL CHEMISTRY

## Isn't it ionic

Microscopic particles dispersed in solvents — known as colloidal suspensions — are attractive models for studying a wide range of phase transitions and nucleation phenomena. The suspended particles can be observed directly in three-dimensional space, and the interactions between them are easily modified. However, processes involving that seemingly most simple and ubiquitous of inorganic solids — ionic crystals formed from oppositely charged atoms — cannot be mimicked by colloids. Charged colloidal particles don't 'do ionic'; they prefer to aggregate instead.

But Mirjam E. Leunissen and colleagues, writing in this issue (*Nature* **437**, 235–240; 2005), show that colloids can be coaxed into forming ionic crystals after all. The authors observed that if salt is added to polymer spheres dispersed in an organic solvent mixture, the charge on the spheres can be controlled and the electrostatic interactions between them can be regulated. This enabled the preparation of binary mixtures of colloids that carried small, opposite charges and readily formed ionic crystals. When an electric field was applied, the crystal melted, and particles of



opposite charge moved towards opposite electrodes.

The charged colloidal particles therefore clearly resemble ionic species. But there are differences. In particular, a diffuse layer of 'counter-ions' surrounds each particle, forming an overall charge-neutral unit that participates in the growth of the crystal. So the structure of the colloidal crystals is not dictated by charge neutrality, as in atomic systems, leaving the authors free to create remarkable

new binary structures. One example, a crystal comprising particles of positive (green, radius 0.36  $\mu\text{m}$ ) and negative (red, radius 1.16  $\mu\text{m}$ ) charge in the ratio 6:1, is shown in the image.

Colloidal crystals can also form from charged spheres made of different materials, such as a polymer and silica. It is then straightforward to burn the polymer spheres away to give all-silica structures. Given the ease with which these structures grow into large crystals, ionic colloids should prove an alluring proposition for those creating advanced materials such as photonic crystals.

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major carbon sources and sinks in the biosphere<sup>2</sup>, with emphasis on protecting existing pools of stored carbon.

Bellamy and colleagues' observations are remarkable, and fall into four categories. First, consistent losses of SOC occurred independently of soil properties, challenging our knowledge about SOC stability. A new hypothesis suggests that the stability of SOC depends on the diversity and activity of soil microorganisms — if microbes have adequate energy resources, they can break down any organic structure irrespective of its physico-chemical stabilization<sup>3</sup>.

Direct measurements of carbon flux do not yet provide a complete picture of the carbon cycle in ecosystems, and the 'mass balance' approach of Bellamy *et al.* is the only available evidence of change in the SOC pool. But the reasons for the loss remain unclear, irrespective of the pathways by which carbon is being lost. Re-inspecting the results, we think that the land-use factor has played a role — for example, only alteration in land use and gradual changes in land management can explain why croplands lost more carbon than other areas. Major land-use changes, such as the afforestation of carbon-rich soils, are not highlighted

of the new findings<sup>1</sup> are considerable. The process of carbon loss from soils has been most comprehensively documented in the United Kingdom, both at regional level and under all forms of land use. But there have also been repeated warning signals from soil surveys in China<sup>10</sup>, Finland<sup>11</sup> and Flanders<sup>12</sup>. These, however, attribute most of the SOC loss to changes in land use and management. In contrast, Bellamy *et al.* provide the first hint that regional climate variation may be contributing to a surprisingly large release of CO<sub>2</sub> from soils to the atmosphere. Further research into the carbon cycle and on reducing CO<sub>2</sub>