overall electronic structure of a compound can be thought of as a hybrid of all of its possible resonance structures, it could be that the dianion-containing resonance structure of Braunschweig and colleagues' borole contributes to the unusual stability of the compound.

There is clearly much more work to be done to explore the chemistry of Braunschweig and colleagues' compound. Perhaps most intriguingly, the borole monoanion might open up new routes for the preparation of other borole derivatives that are otherwise difficult to make. If so, maybe we will finally have a chance to fully investigate the chemistry of this fascinating family of organoboron compounds. ■

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MATERIALS SCIENCE

A cloak of liquidity

A. Lindsay Greer

Droplets of a liquid alloy on a silicon surface can rearrange the surface atoms so that they mimic the short-range ordering of atoms in the alloy. Remarkably, this effect inhibits freezing of the droplets.

Promoting freezing in a liquid is conceptually straightforward — you simply need to add suitable templates. The templates can be either 'seeds' of the crystalline phase that would form from the liquid, or small crystals of another material whose atomic-level surface structure in some way matches that of such seeds.

What is much more difficult to conceive of is a solid surface that inhibits freezing by acting as a template for the liquid. However, on page 1174 of this issue, Schülli *et al.*[1] describe evidence suggesting that such a template is possible. Their results have wide implications not only for fundamental studies of freezing, but also for the practical control of this phase transition.

When a liquid is cooled, there is a thermodynamically defined temperature — the freezing point, or liquidus temperature — at which it should start to crystallize. But the crystal nucleation that initiates freezing requires a driving force, and occurs only at temperatures below the ideal freezing temperature. The cooling of a liquid to below the ideal freezing temperature, known as supercooling (Fig. 1), is of great interest in diverse areas ranging from the control of microstructure in metallic welds and castings[2] to the inhibition (or promotion) of ice formation necessary for the survival of living systems[3]. Although in some situations it is desirable to nucleate crystals at the highest possible temperature by minimizing supercooling, in others the challenge is to avoid nucleation so that liquids and their freezing processes can be studied at the lowest temperature possible (greatest possible supercooling).

Schülli *et al.*[1] studied the freezing of a liquid gold–silicon alloy near its eutectic (lowest freezing point) composition. Not only is this alloy a useful model system, but it also has practical significance — it is used in the vapour–liquid–solid process for growing silicon nanowires[4]. The authors formed microscopic islands of gold on a single-crystal silicon substrate and heated them until they melted, whereupon some of the silicon dissolved into the gold to form liquid-alloy droplets. On cooling, these droplets froze at a temperature that was reproducible over repeated heating–cooling cycles, but that depended greatly on the upper temperature limit of the heating.

Using an X-ray scattering technique under ultra-high vacuum conditions, Schülli *et al.*[1] characterized the structure of the liquid–substrate interfaces in their system *in situ*. They found that on crystallographically defined silicon substrates (for which particular planes within the lattice were exposed at the surface) the freezing point of the gold–silicon alloy was generally 563 kelvin. By performing a detailed analysis of extensive X-ray data acquired at a wide range of angles to the substrate, the authors showed that this freezing point corresponds to a slight, gold-induced reconstruction of the atomic arrangement of the silicon surface. But when the team had previously heated the liquid to temperatures above 673 K, the onset of freezing was remarkably depressed to 513 K. In this case, the authors observed that the silicon had undergone a more radical reconstruction to yield what is known as a 6 × 6 superstructure.

Figure 1 | Natural supercooling. These trees are covered in rime ice, which forms when supercooled water droplets in the atmosphere come into contact with cold objects and freeze rapidly.

PHOTOLIBRARY.COM

The freezing point of the alloy in contact with the 6 × 6 silicon surface is about 120 K below that of eutectic gold–silicon, but Schülli *et al.* point out that the eutectic freezing temperature is not the most appropriate reference point from which supercooling of the system should be measured. As the liquid alloy droplets cool, silicon comes out of solution and redeposits on the substrate, enriching the droplets in gold. The observed freezing point of 513 K therefore represents a supercooling of about 360 K below the liquidus of the resulting composition. This is more than 40% of the expected freezing temperature, an exceptionally high value for a metallic system[5].

This supercooling is all the more

remarkable because of the ordering of the liquid at the solid–liquid interface. It is accepted that a liquid in contact with a planar solid shows out-of-plane ordering — the liquid atoms form layers parallel to the surface of the solid[6]. This might be thought to favour crystallization of the liquid, but whether or not this is so depends on the nature of the atomic ordering within each layer (in-plane ordering), the characterization of which has proved challenging[7]. In-plane ordering is exactly what would be expected when a liquid comes into contact with a substrate that acts as a template for crystal nucleation in freezing.

Schülli *et al.*[1] have succeeded in the difficult task of characterizing in-plane order in the liquid gold–silicon alloy adjacent to the 6×6 silicon surface. They found that the liquid is anisotropic, with atomic positions strongly correlated with the structure on the underlying surface. It is remarkable that this correlation with a periodic surface pattern impedes the crystallization of the liquid, rather than inducing it.

The researchers[1] also characterized the structure of the gold–silicon liquid away from the silicon substrate and found that, in common with most metallic liquids[8], it shows icosahedral short-range order that becomes more pronounced on cooling. Crucially, the authors observed that the pentagonal clusters of atoms typical of the icosahedral order seem to be stabilized by similar pentagonal arrangements in the 6×6 silicon superstructure (see Fig. 4 on page 1177). However, when the alloy droplets freeze on the 6×6 silicon surface, the resulting gold crystals form in random orientations. This suggests that the substrate has no orienting role in freezing; the actual site and mechanism of crystal nucleation remain undetermined.

For several years, there has been intense interest in attaining a large supercooling effect of liquids before the onset of freezing. To avoid crystal nucleation caused by contact with a solid, the favoured strategy is to process the liquid without using a container. This can be done in various ways[9], including by levitating liquid drops electromagnetically, electrostatically or acoustically, or by studying drops as they fall through a tube or tower. Because the surface energies of most liquids are lower than those of the crystals that form from them[10], free surfaces — in these experiments, the liquid surfaces at air–liquid interfaces — also stabilize the liquid state of levitating or free-falling drops. The work of Schülli *et al.*[1], however, opens up an attractive alternative to dispensing with the container: why not just disguise the container's surface as a liquid?

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INFECTIOUS DISEASE

Listeria does it again

Julian I. Rood

Proteins are synthesized by ribosomes, and then commonly undergo further modifications. A new example of how these host-cell processes can be subverted by a pathogenic bacterium has come to light.

There are many ways by which pathogenic bacteria produce the cell and tissue damage that leads to human disease. On page 1192 of this issue Ribet *et al.*[1] reveal another such mechanism — they show that *Listeria monocytogenes* can alter an essential host-cell biochemical pathway, and potentially decrease the ability of the host to respond to infection.

The development of an infectious disease is a tactical war between the attacking armaments of the invading pathogen and the defence mechanisms of the host. With some pathogens a single potent virulence factor will suffice. With others the host cell has to counter many different factors, as is the case when the cell is attacked by *L. monocytogenes*. This food-borne bacterium can cause several diseases, including gastroenteritis, septicaemia and meningitis, and also miscarriage[2]. It produces several virulence factors that enable it to invade host cells, and to grow and multiply within them. The complexity of this process makes it a model bacterial pathogen for understanding the infectious-disease process, from both a host and a pathogen perspective. Examples of discoveries stemming from the study of *L. monocytogenes* (Fig. 1) include the determination of the role of extracellular toxins in bacterial escape from the phagolysosome (the bactericidal vacuole of the invaded host cell),

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50 & 100 YEARS AGO

50 YEARS AGO

This article describes a model which imitates certain aspects of morphogenesis and maintenance in a developing embryo. The model consists of a number of artificial 'cells' (constructed from radio parts) which can stimulate and inhibit one another by means of connexions which are made through a switchboard. The pattern of activity generated, representing the growth pattern, was found to bear a remarkable resemblance to certain aspects of morphogenesis ... Many other properties of our system, with larger numbers of cells and with other ways of connecting them together, are reminiscent of the properties of growing embryos: for example, the patterns are in general homeostated — a disturbance producing only a temporary change in the pattern. Discrete differences (such as 'on' or 'off') appear between neighbouring cells, in contrast to the continuous differences which would be expected on a purely humoural mechanism of growth control.

Dr. R. J. Goldacre and A. D. Bean

From *Nature* 23 April 1960.

100 YEARS AGO

In her letter to NATURE on March 24 Miss I. Sollas remarks on the "canary-yellow" colour "in members of the stoat family when the winter whitening is incomplete," adding, "there can thus be little doubt that the yellow body produced artificially in the fur of the albino rat is a substance similar to the yellow pigment of the stoat's winter coat ..." I do not know whether it has been recorded ... that a stoat's fur of the purest white will, after exposure to light in a museum case for a time, varying with the intensity of the light, invariably turn distinctly yellow — fainter, however, than "canary-yellow." ... The usual reason assigned for the change is the absorption by the hairs of a small amount of fat out of the skin, induced by the light and heat of summer.

Henry O. Forbes

From *Nature* 21 April 1910.