Bone's bridged layers

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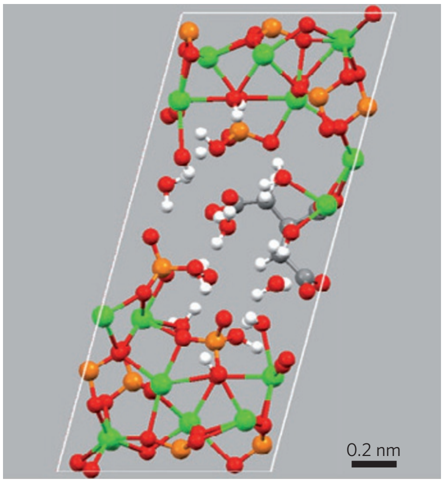

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The mineral phase of bone is composed of stacks of apatite platelets parallel to each other and to the neighbouring collagen fibrils, and of a highly hydrated disordered phase containing most of the mineral's phosphate ions. However, the location of the hydrated phase is unclear, and how the stack of mineral platelets is formed and maintained is unknown. Now, Melinda Duer and colleagues propose a model of bone mineral where mineral platelets are bridged by disordered citrate ions residing within inter-platelet hydrated layers. Supported by solid-state nuclear magnetic resonance spectroscopy, X-ray diffraction and first-principles electronic-structure calculations, the model explains why the bone-mineral structure is preserved when the surrounding protein is removed and why the amount of structured water observed in bone mineral is larger than that of synthetic models of it. It also explains the presence of substantial amounts of disordered and immobile hydrogen phosphate ions in the platelet stacks, and has implications for the understanding of the mechanical properties of bone and of the changes in bone-mineral crystallinity associated with certain metabolic diseases. *PP*

Biogenic agents

Nature Nanotech. **9,** 311–316 (2014)

Gas-filled microbubbles are used at present in contrast-enhanced ultrasound imaging for biomedical applications; however, these structures tend to be unstable at sizes below 1 μm. For molecular imaging, nanoscale contrast agents are required but few such systems have been developed. Now, Mikhail Shapiro and colleagues report the ability of gas-filled nanostructures formed from microorganisms to show stable ultrasound contrast both *in vitro* and *in vivo*. The gas vesicles, formed from bacteria or archaea, have specific, genetically encoded protein shells and allow gas in the surrounding media to freely diffuse in and out of them, but do not allow water to permeate inside. The absence of a pressure build-up between the outside and inside of the vesicles allows them to remain stable. The nanostructures are either cylindrical or biconical in shape and have widths between 45–250 nm and lengths between 100–600 nm. The critical pressure at which the gas vesicles collapse varies with the microorganism from which they are formed. This can be exploited to cause 'serial collapse' of multiple vesicles, enabling the different vesicles to be distinguished *in situ*. *AS*

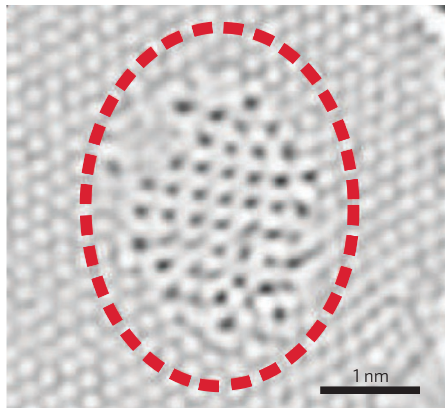
Seismic cloaks

Phys. Rev. Lett. **112,** 133901 (2014)

Cloaking, the ability to render an object invisible to electromagnetic and acoustic waves, has been the subject of intense research thanks to recent developments in the field of metamaterials. A cloaking metamaterial acts as an invisibility shield, which cancels any presence of the propagating wave within the shielded region. This is a powerful idea that has potential applications beyond electromagnetic and acoustic cloaking. Stéphane Brûlé and co-workers have now proposed a proof of concept by applying this idea to realize a seismic cloak. In their experiment, the authors built a seismic metamaterial constituted of a 'mesh' of vertical cylindrical voids dug out of silty clay soil and analysed its masking behaviour by shocking it with 50-Hz seismic waves. Their results show how the metamaterial is capable of strongly attenuating the energy of the seismic wave, as close as 10 m from the wave epicentre. *ON*

Two-dimensional iron

Science **343,** 1228–1232 (2014)



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The single characteristic that defines the celebrated electronic, mechanical and thermal properties of graphene is its two-dimensional (2D) nature. Although the family of 2D materials has recently been expanded to include monolayer transition-metal dichalcogenides, for example, isolating free-standing monolayers of metals such as iron and cobalt has been more difficult. There are many examples of low-dimensional metals grown on substrates, even down to the monolayer limit, but significant hybridization effects significantly influence their behaviour. Now, a group led by Mark Rümmeli has shown that single-layer sheets of iron can be stabilized within perforations inside graphene sheets. In this way the degree of interaction between the iron and the graphene is minimal, and the closest thing to a free-standing 2D metal is achieved. The authors use aberration-corrected transmission electron microscopy to image the structures, and perhaps more intriguingly, they predict by means of numerical simulations that these structures should intrinsically display enhanced magnetic properties. *AT*

Bioresorbable organic electronics

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In view of their high sensitivity to gate modulation, organic electrochemical transistors based on a poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) conducting channel have been proposed as probes that can be used *in vivo* to record signals from electrogenic cells. Alessandra Campana and colleagues have now developed a protocol to fabricate these devices on resorbable substrates. They used shadow-mask deposition to form the metal contacts and dry etching of the thin PEDOT:PSS layer spin-coated on poly(L-lactide-co-glycolide) — a biocompatible and biodegradable copolymer used for temporary implants — to realize transistors that are able to detect voltage signals with amplitudes and frequencies comparable to those of extracellular action potentials. The probes were tested by attaching to human skin and taking electrocardiographic measurements; they recorded cardiac waveforms with good fidelity. The researchers suggest that high-performing organic electronics based on materials that are mechanically compliant with human tissues, biocompatible and fully resorbable will be a key technology for the realization of implantable devices with minimal invasiveness. *LM*

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