stability is of paramount importance for possible applications in catalysis, electronics and sensing, where the material is typically exposed to relatively high temperatures. Then, further investigations regarding the MOCs stability would be required to assess the limits of application of such materials for the targeted final uses.

Finally, the versatility of the synthesis approach already demonstrated in this work, as well as the future expansion to other transition metals, could allow the realization of novel chalcogenide–organic frameworks tailored for other uses, such as superconductors, thermoelectrics, sensors and catalysis. Particularly, the development of biocompatible and highly photoluminescent solids with high quantum yield could be envisaged, and this may open new possibilities for biological applications. Also, the formation of chiral metal–organic chalcogenide nanowires aided by the use of enantiomerically pure organothiols could be a promising route for affording optical chirality in solid materials. ❐

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MATERIAL WITNESS

METALLIC HYDROGEN IN THE SPOTLIGHT

PHILIP BALL

Healthy scepticism seems to be the wise position on the latest evidence for metallic hydrogen[1]. Isaac Silvera of Harvard University — who has been worrying away at this challenge for decades — and his colleague Ranga Dias report that they have squeezed solid molecular hydrogen to a metallic state in a diamond anvil cell at a pressure of 495 GPa and a temperature of around 5.5 K. The claim is based primarily on the observation that the material between the diamond teeth changes from dark to reflective.

While some media reports have uncritically celebrated this as the end of an 80-year quest, the more scientifically savvy have pointed out that the results rest on a single observation. Can we rely on a pressure that is not directly measured but only extrapolated from a calibration of screw turns in the anvil cell? Can we be sure that the reflective material is indeed hydrogen and not the thin coating of alumina applied to the diamond teeth to prevent hydrogen diffusion into the diamond and its consequent embrittlement?

This field is no stranger to hasty claims. A 2011 report in this very journal by Eremets and Troyan[2] of a conductive, metallic phase of hydrogen made at room temperature and around 260 GPa was met with widespread doubt, some of it from the Harvard group[3]. As one critic said, such claims need to be supported by "enough experiments, with enough controls, to compile enough lines of evidence to convince even the pickiest of critics." The new claim hardly meets those criteria either.

How striking, though, that researchers have tried so hard for so long — for once the cliché of a 'holy grail' seems valid. Making metallic hydrogen has been a goal of high-pressure physics ever since 1935, when Eugene Wigner and Hillard Bell Huntington proposed that the molecular solid should adopt this state[4]. They pointed out that the metallic phase should appear when the lattice becomes essentially monatomic, with all hydrogen atoms translationally identical — a possibility, they said, consistent with J. D. Bernal's view that all substances should adopt a metallic state at sufficiently high pressures.

Bernal's prediction has been borne out for other simple molecular substances such as sulfur[5] and bromine[6]. Perhaps it is the stark simplicity of the hypothetical metallic hydrogen that makes it so attractive. The stakes were raised, however, by Ashcroft's prediction that it should also furnish a superconductor[7], perhaps with a remarkably high transition temperature[8]. This was enough to elicit some breathless news reports of the latest work illustrated with Maglev trains — fuelled by Dias and Silvera with optimistic talk of somehow quenching metallic hydrogen and searching for a "pathway for production in large quantities."

The other hook for metallic hydrogen is the notion that it constitutes the greater part of the interior of gas-giant planets like Jupiter, albeit in liquid form. Studying this 'hot' dense fluid phase of hydrogen is no less challenging[9], but there have already been claims to have made the metallic liquid in shock-compression experiments[10] and the diamond anvil cell[11]. In this unusually competitive, high-stakes game, there's little sign of bold claims and controversies abating any time soon. ❐

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