Reviewing pressure effects on iron-based high-temperature superconductors

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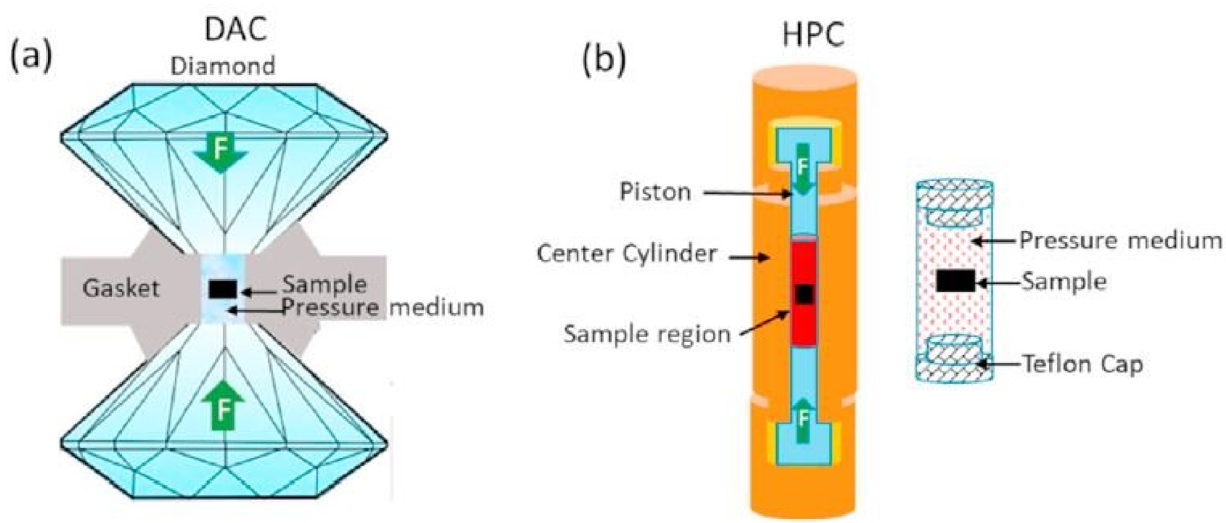

Experimental equipment: The diamond anvil cell (left) and hydrostatic pressure cell (right) can be used to establish the effect of pressure on superconducting material. Credit: FLEET

The discovery of iron-based superconductors with a relatively high transition temperature T_c in 2008 opened a new chapter in the development of high-temperature superconductivity.

The following decade saw a research boom in superconductivity, with remarkable achievements in the theory, experiments and applications of iron-based superconductors, and in our understanding of the fundamental mechanism of superconductivity.

A UOW paper published last month reviews progress on high-pressure studies on properties of iron-based superconductor (ISBC) families.

FLEET Ph.D. student Lina Sang (University of Wollongong) was first author on the Materials Today Physics review paper, investigating effects on the superconductivity, flux pinning, and vortex dynamics of ISBC materials, including:

- pressure-induced superconductivity
- raising transition temperature T_c
- pressure-induced elimination/re-emergence of superconductivity
- effects of phase separation on superconductivity
- increasing critical current density
- significantly suppressing vortex creep
- reducing flux bundle size.

The review spotlights use of pressure as a versatile method for exploring new materials and gaining insight into the physical mechanisms of high-temperature superconductors.

Superconductors: A background

In a superconductor, an electrical current can flow without any energy loss to resistance.

Iron-based superconductors are a type of 'high temperature' (Type II or unconventional) superconductor in that they have a transition temperature (T_c) much higher than a few degrees Kelvin above absolute zero.

The driving force behind such Type II superconductors has remained elusive since their discovery in the 1980s. Unlike 'conventional' superconductors, it is clear they cannot be directly understood from the BCS (Bardeen, Cooper, and Schrieffer) electron-phonon coupling theory.

In successive discoveries, the transition temperature T_c has been driven steadily higher.

"The ultimate goal of the research of superconductivity is finding superconductors with a superconducting transition temperature (T_c) at room temperature," says Prof Xiaolin Wang, the node leader and theme leader of FLEET (also at the University of Wollongong) and Dr. Sang's Ph.D. supervisor.

"Pressure can significantly enhance the T_c for the Fe-based superconductors. And recently, superconductivity was observed near room temperature in hydrogen alloyed compounds," explains Prof Wang, who is Director of the Institute for Superconducting and Electronic Materials at the University of Wollongong.

"Pressure effects on iron-based superconductor families: Superconductivity, flux pinning and vortex dynamics" was published in *Materials Today Physics*.

More information: L.N. Sang et al, Pressure effects on iron-based superconductor families: Superconductivity, flux pinning and vortex dynamics, *Materials Today Physics* (2021). DOI: 10.1016/j.mtphys.2021.100414

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