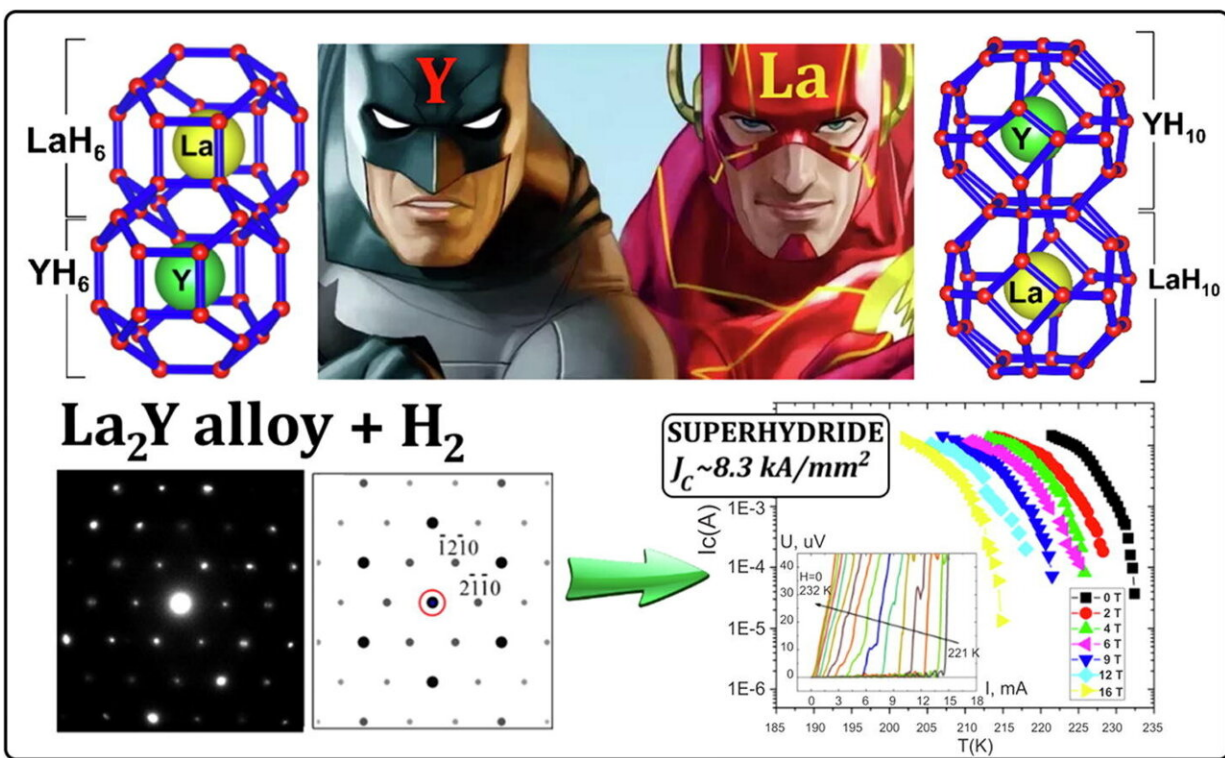


New ternary hydrides of lanthanum and yttrium join the ranks of high-temperature superconductors

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Graphical abstract. *Materials Today* (2021). DOI: 10.1016/j.mattod.2021.03.025

A team led by Skoltech professor Artem R. Oganov studied the structure and properties of ternary hydrides of lanthanum and yttrium and showed that alloying is an effective strategy for stabilizing otherwise unstable

phases YH_{10} and LaH_6 , expected to be high-temperature superconductors. The research was published in the journal *Materials Today*.

Cuprates had long remained record-setters for high-[temperature superconductivity](#) until H_3S was predicted in 2014. This unusual sulfur [hydride](#) was estimated to have [high-temperature superconductivity](#) at 191–204 K and was later obtained experimentally, setting a new record in superconductivity.

Following this discovery, many scientists turned to superhydrides, which are abnormally rich in hydrogen, and discovered new compounds that became superconducting at even higher temperatures: LaH_{10} (predicted and then experimentally shown to have superconductivity at 250-260 K at 2 million atmospheres) and YH_{10} (predicted to be an even higher temperature superconductor). Despite the similarity between yttrium and lanthanum, YH_{10} proved to be unstable, and thus far no one has succeeded in synthesizing it in its pure form. Having reached the upper limit of critical temperatures for binary hydrides, chemists turned to ternary hydrides which appear as the most promising path towards still higher temperature superconductivity. Finally in 2020, after over 100 years of research, scientists were able to synthesize the first room-temperature superconductor—a ternary sulfur and carbon hydride – with a critical temperature of +15 degrees Celsius.

In their recent work, scientists from Skoltech, the Institute of Crystallography of RAS, and V.L. Ginzburg Center for High-Temperature Superconductivity and Quantum Materials studied ternary hydrides of lanthanum and yttrium with different ratios of these two elements.

"Although lanthanum and yttrium are similar, their hydrides are different: YH_6 and LaH_{10} do exist, while LaH_6 and YH_{10} do not. We

found that both structures could be stabilized by adding the other element. For example, LaH_6 can be made more stable by adding 30 percent of [yttrium](#), and its critical superconductivity temperature is slightly higher as compared to YH_6 ," professor Oganov says.

In addition, the research has helped to elucidate the general profile of [superconductivity](#) in ternary hydrides. "We realized that ternary and quaternary hydrides have progressively less ordered structures and a much greater width of the superconducting transition than binary hydrides. Also, they require more intensive and longer laser heating than their binary counterparts," lead author and Skoltech Ph.D. student Dmitrii Semenok explains.

The scientists believe that the study of ternary hydrides holds much promise for stabilizing unstable compounds and enhancing their superconducting performance.

More information: Dmitrii V. Semenok et al, Superconductivity at 253 K in lanthanum–yttrium ternary hydrides, *Materials Today* (2021). [DOI: 10.1016/j.mattod.2021.03.025](https://doi.org/10.1016/j.mattod.2021.03.025)

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