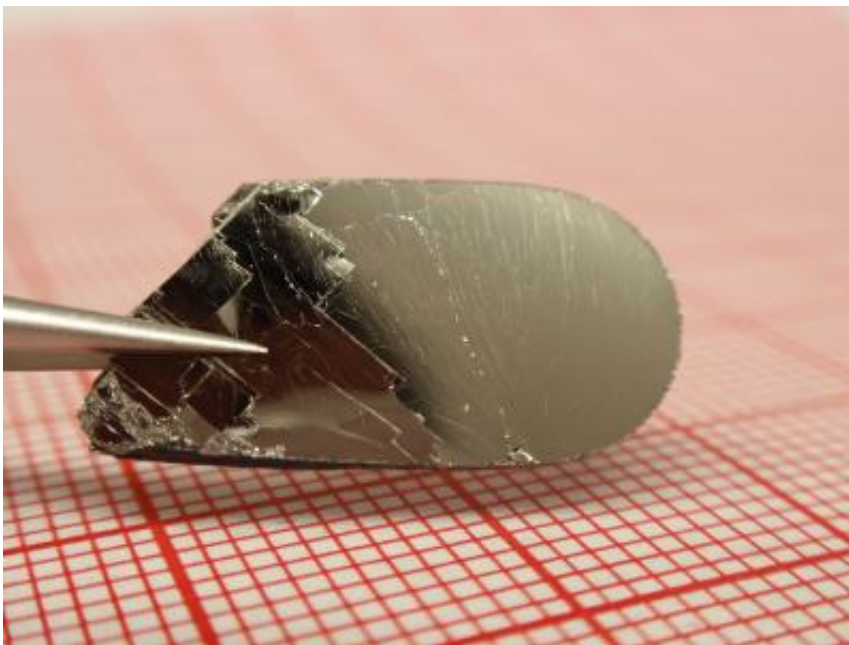


Scientists gain insight on mechanism of unconventional superconductivity

October 18 2016, by Ruslan Prozorov



A crystal sample of one of the iron-based unconventional superconductors studied by Ames Laboratory scientists. Their systematic investigation of this class of superconductors may lead to the creation of new materials with unique superconducting properties. Credit: U.S. Department of Energy, Ames Laboratory

Researchers at the U.S. Department of Energy's Ames Laboratory and partner institutions conducted a systematic investigation into the properties of the newest family of unconventional superconducting materials, iron-based compounds. The study may help the scientific

community discover new superconducting materials with unique properties.

Researchers combined innovative crystal growth, highly sensitive magnetic measurements, and the controlled introduction of disorder through electron bombardment to create and study an entire range of compositions within a class of iron-based superconductors. They found that the key fundamental properties—transition temperature and magnetic field penetration depth—of these complex superconductors were dependent on composition and the degree of disorder in the material structure.

"This was a systematic approach to more fully understand the behavior of unconventional superconductors," said Ruslan Prozorov, Ames Laboratory faculty scientist and professor in the Department of Physics and Astronomy at Iowa State University. "We found that some proposed models of unconventional superconductivity in these iron-based compounds were compatible with our results, and this study further limited the possible theoretical mechanisms of superconductivity." Researchers combined innovative crystal growth, highly sensitive magnetic measurements, and the controlled introduction of disorder through electron bombardment to create and study an entire range of compositions within a class of [iron-based superconductors](#). They found that the key fundamental properties—transition temperature and magnetic field penetration depth—of these complex superconductors were dependent on composition and the degree of disorder in the material structure.

"This was a systematic approach to more fully understand the behavior of unconventional superconductors," said Ruslan Prozorov, Ames Laboratory faculty scientist and professor in the Department of Physics and Astronomy at Iowa State University. "We found that some proposed models of [unconventional superconductivity](#) in these iron-based

compounds were compatible with our results, and this study further limited the possible theoretical mechanisms of superconductivity."

That information will also serve as a resource for future research into [unconventional superconductors](#).

"This study fleshed out the knowledge of a class of materials more completely and in a way that will be helpful to the scientific community as they search for [high temperature superconductors](#). Knowing how transition temperature is affected by composition, magnetic field and structural disorder gives science a better idea of where to dig—it contributes to the goal of discovery by design, creating materials that do exactly what we want them to do," said Prozorov.

The research is discussed in a paper published in *Science Advances*, "Energy Gap Evolution Across the Superconductivity Dome in Single Crystals of $(\text{Ba}_{1-x}\text{K}_x)\text{Fe}_2\text{As}_2$ ", and co-authored by Kyuil Cho, M. Kończykowski, S. Tekowijoyo, M.A. Tanatar, Y. Liu, T.A. Lograsso, W.E. Straszheim, V. Mishra, S. Maiti, P.J. Hirschfeld, and R. Prozorov

More information: K. Cho et al, Energy gap evolution across the superconductivity dome in single crystals of $(\text{Ba}_{1-x}\text{K}_x)\text{Fe}_2\text{As}_2$, *Science Advances* (2016). [DOI: 10.1126/sciadv.1600807](https://doi.org/10.1126/sciadv.1600807)

Provided by Ames Laboratory

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