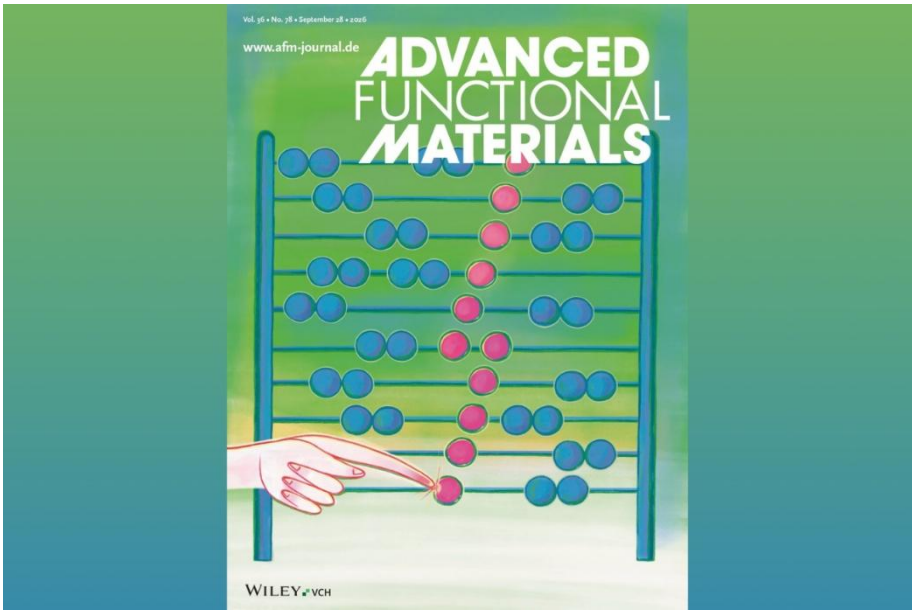
A laser can draw superconductivity at the nanoscale

A direct laser writing technique enables the nanoscale control of the superconducting and magnetic properties of a high-temperature superconducting material



This article has been the inside cover of Adv. Funct. Mater. 78/2026 | Biancardi et al. (2026). Available in Advanced Functional Materials, 36(78)

Cerdanyola - Milano, October 23, 2026 – Researchers from the Politecnico di Milano, ICMAB-CSIC, and Universtité de Liège have adapted a direct laser writing technique that allows them to “draw” superconducting properties in a material. The result is a new way to locally programme the behaviour of a superconductor, tuning it from a fully superconducting state to an insulating one with extraordinary precision.

High-temperature superconductors (HTSC) are materials that can conduct electricity without resistance at higher temperatures than conventional superconductors. Since they can operate at temperatures achievable using inexpensive liquid nitrogen cooling, they are considered promising candidates for future applications such as quantum technologies, superconducting electronics, or next-generation memory devices.

However, patterning HTSC is particularly difficult at very small scales, as their ceramic nature makes them sensitive to conventional micro- and nanofabrication methods. The level of oxygen of the material is what is key to determine its behaviour: whether it is superconducting or insulating.

“Having a whole homogeneous sample, all well oxygenated, is easy. As well as having it uniformly deoxygenated”, says **Anna Palau**, one of the paper’s corresponding authors. “The difficult part is to have small patterns with different oxygenation levels throughout the same film.”

A laser that “draws” like a pen

To overcome this limitation, the researchers used a focused laser to locally modify the material, controlling the oxygen levels point-by-point with high precision. “By varying the laser power and exposure time, we were able to create regions with different properties, allowing us to pattern the material in a similar way of a pen in a paper”, says Irene Biancardi, the first author of the study. That pattern then allows to have parts that are insulating next to superconducting ones, as well as any intermediate gradient.

“This approach opens new possibilities for the design of superconducting devices with tailored properties. The ability to locally tune superconducting behaviour could be exploited in devices such as resonators, memory elements and components for quantum technologies, and could contribute to more energy-efficient information and communication technologies”, explain **Edoardo Albisetti and Daniela Petti**, corresponding authors of the study with Anna Palau. The research received funding from the H2020 ERC Starting Grant B3YOND (no. 948225).

Original paper

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ICMAB-CSIC
Communication department
Tel.: +34 93 580 18 53
communication@icmab.es
icmab.es

POLITECNICO DI MILANO
Media Relations
Tel. +39 3316480248
relazionimedia@polimi.it
polimi.it