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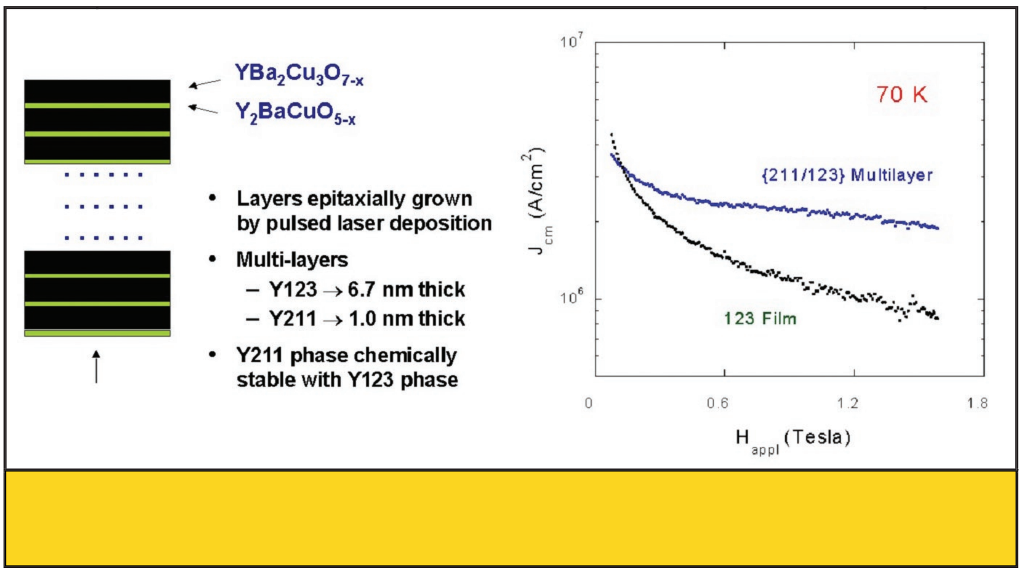
*Science and Technology for Tomorrow's Air and Space Force*

## Success Story

# PROPULSION DIRECTORATE SCIENTISTS DEMONSTRATE SIGNIFICANT ADVANCE IN SUPERCONDUCTIVE MATERIALS




Scientists from the Propulsion Directorate produced and demonstrated a flux pinning mechanism for superconducting material that will bring completely new classes of high-power generators and electrically driven weapon systems closer to reality.

Air Force Research Laboratory
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## Accomplishment

The directorate's Superconductivity Group developed a new method for flux pinning superconductive yttrium-barium-copper-oxide (YBaCuO)-coated substrates. By laser depositing alternating layers of superconducting and non-superconducting material, the team dramatically improved the current carrying capability of the material in higher magnetic fields.

This increase in flux pinning doubled the material's critical current density at 70º Kelvin (K) 1 Tesla, over that of a normally prepared sample. In an initial sample prepared by the group, the critical current density was even more than double at applied fields greater than 1Tesla, 70º K.

## Background

Flux pinning is an important phenomenon in superconductivity. Flux pinning traps or "pins" magnetic lines of force, called fluxons, inside superconducting material.

Superconductors can carry a bulk current density only if the pinning maintains the macroscopic fluxon density gradient. Increasing the magnetic field, or temperature, weakens the potential wells of the pinning sites.

If the fluxon density gradient is lost, the superconducting material loses its superconducting properties. Flux pinning depends on the actual crystalline structure of the superconducting material and has an impact on the amount of current a superconductor can handle. Higher current density results when magnetic lines of flux are effectively "pinned" within the superconducting material.

In the directorate's approach, the incorporated non-superconducting layers are only about a nanometer in width. A key element is the use of non-superconducting interlayer compounds that are not chemically reactive with the high-temperature superconducting (HTS) material.

This is a critical characteristic as many compounds diffuse and react with the HTS during the high-temperature processing when using thin layers. The scientists used pulsed laser deposition to make alternating layers of $YBa_2Cu_3O_{7-x}$ superconducting and $Y_2BaCuO_{5-x}$ non-superconducting material. Scientists can also use this process in other thin film deposition or coating techniques and with other HTS materials.

Propulsion
Emerging Technologies

## Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (02-PR-04)