Solution Deposition Planarization

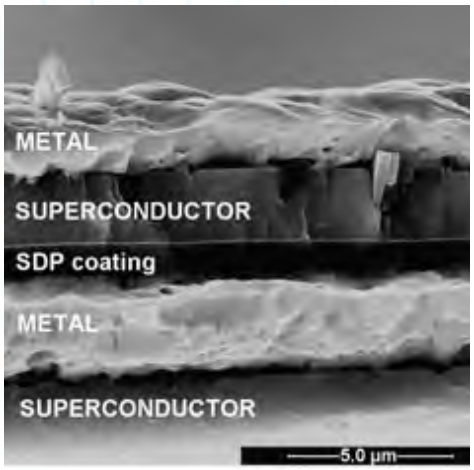
Sandia National Laboratories, Los Alamos National Laboratory, Superconducting Technologies Inc., Superpower

Problem

The electric grid relies on transmission of power from the production source – be it a coal-fired plant, solar array, or wind farm – to the customer. Energy transmission results in a great deal of energy loss due to resistance in the conducting material. Superconducting wires offer zero power dissipation and higher maximum current densities when contrasted with traditional copper or aluminum analogues, but it also requires costly manufacturing techniques. This state-of-the-art wire has the potential to impact electric power transmission as fiber optics has for communications. However, production costs must be reduced before it can achieve this potential. In an effort to lower manufacturing costs and to support higher power densities, Sandia collaborated with Los Alamos National Laboratory to develop solution deposition planarization (SDP), a process used in the creation of lower-cost superconducting wire.

Innovative Edge

A precisely aligned crystal structure is required for superconducting wire to achieve its high electrical current capacity. Creating the required degree of alignment involves the use of SDP in conjuction with ion beam assisted deposition (IBAD). In IBAD, a single-crystal-like oxide template is applied to the metal substrate, then the superconducting layer is deposited on the thin 5-nm IBAD layer. SDP provides the smooth surface required to achieve the desired thinness.



Solution deposition planarization.

The SDP process involves dip-coating rough metal tapes in a liquid precursor mixture and then annealing the coating to reduce roughness. The planarized coating then enables kilometer-length deposition of ion beam-textured templates and bi-axially oriented superconductor films at high speeds and low production costs. In addition, the SDP process eliminates toxic waste and removes three expensive processing steps to achieve high performance superconducting wires.

Commercialization and Industry Impact

Superpower and Superconducting Technologies Inc. are implementing SDP as a critical process in their production of high power density-supporting superconducting wire. Superconducting Technologies Inc. uses SDP in its manufacturing process to produce the Conductus 2G high temperature superconducting wire and describes SDP as an “inexpensive process, which provides a smooth starting surface while eliminating the need to polish the template, reducing both cost and chemical waste.”

Lower manufacturing costs for superconducting wire will facilitate greater use of the robust, efficient material. Superconducting wires will revolutionize efficient power transmission by enabling new products such as smaller motors and wind turbines, as well as nearly-zero energy loss long-length direct current energy transmission lines for use with renewable energy technologies.