

Characterization of YBCO Superconducting Thin-Films for Fluxonic Applications

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Abstract:

The use of superconducting materials for thin film oxides has recently sparked interest in a new field of engineering research called “Fluxonics,” named after the physical quantization of magnetic flux lines that occurs in such materials when a threshold current has been injected. Structures consisting of patterned indentations, termed “antidots,” have been fabricated using standard ultraviolet (UV) lithography methods on high-temperature Type II superconductors such as yttrium-barium-copper-oxide (YBCO) to structurally guide and support magnetic flux vortices. Various growing and processing conditions concerning film qualities, topological constructions, and antidot geometry arrangements have been investigated for their effectiveness in meeting the criteria for several electronic and computing applications, one of which is the development of a super-fast method for storing and processing data [1].

The focus of this project was to characterize critical parameters of a superconducting thin film to be used for antidot patterning. Novel samples of YBCO with a cerium oxide (CeO₂) buffer layer were previously grown on an R-cut sapphire substrate. For characterization, a liquid helium cryostat and an inductive coil system with a built-in heater were implemented. Automatic testing algorithms were written and administered through LabVIEW. Extracted critical temperature and voltage values were indicative of the sample’s successful onset of superconductive behavior.

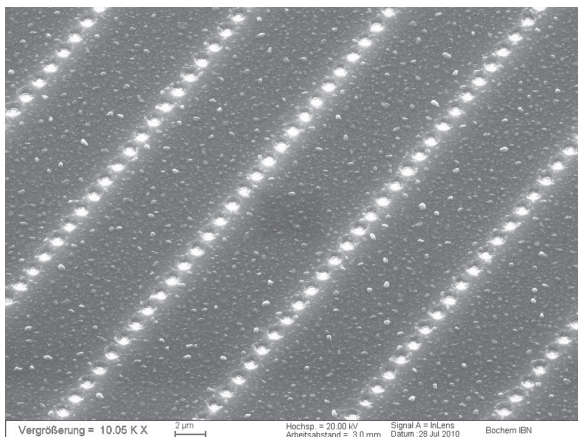


Figure 1: SEM image of the surface topology for a completed antidot structure (2010).

layer on an appropriately buffered substrate, are useful for their potential in understanding vortex dynamics. It has recently been determined that for microwave experiments, YBCO may be optimally grown on a suitable substrate such as aluminum oxide (Al₂O₃, sapphire) with an introduced CeO₂ buffer layer, which acts as both a lattice-matched interface between dissimilar unit cells and an inhibitor to the possible diffusion of aluminum [2]. Figure 1 depicts a scanning electron microscopy (SEM) image of the surface topology of a fully completed antidot structure.

Prior to its utilization as a finished structure, a sample wafer must first be characterized to ensure its functionality as a superconductive material [3]. In this experiment, we have successfully characterized the critical temperature and voltage of a previously grown thin-film sample (R2Z5-47.c), consisting of 100 nm of YBCO grown on a 30 nm thick CeO₂ buffer layer on an R-cut sapphire substrate.

Introduction:

Recent developments in the field of complex oxide thin films have led to the study of magnetic flux vortex movements within patterned indented structures. These antidot structures, comprised of a Type II superconducting

Experimental Procedure:

For characterization, a sample of R2Z5-47.c was structurally supported between two inductive coil pads and suspended

