Fabrication and characterizations of superconducting yttrium barium copper oxide nanowires

By

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Date: 29 July 2019 (Monday)
Time: 10:00
Venue: Room 4582 (Lift 29-30)

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Abstract

In this research, deposition of oxide based high temperature superconducting material, namely Yttrium barium copper oxide (YBCO) into mesoporous structure is achieved by a modified chemical vapor deposition (CVD) and with addition aid of ball-milling. Substrate including mesoporous silica Santa Barbara Amorphous No. 15 (SBA-15) with pore diameter of 8nm to 14nm and Anodic alumina oxide (AAO) with pore diameter of 30nm to 60nm are used as template.

The main objective of this research is to produce an array of YBCO nanowires with diameter smaller or similar to the value currently reported from journals. During the time of research, the smallest diameter reported for YBCO is 38nm. YBCO powders are fabricated via hand grinding and ball milling of precursors of Yttrium, Barium and Copper in the form of Dipivaloymethane (DPM). The powders undergo CVD with the selected substrate, which allow deposition inside the pore and formation of YBCO nanowires. For SBA-15/YBCO, the mixture is directly characterized by TEM as the SBA-15 structure can be see-through under TEM. For the AAO/YBCO, the template is cleanse with sodium hydroxide (NaOH) to remove the AAO, in which bundles of YBCO nanowires are obtained for TEM analysis. The template is characterized using BET, while product is characterized using TEM, EDX and also XRD. The SBA-15/YBCO combination is unable to product any YBCO nanowires due to the small pore size. For the AAO/YBCO mixture, YBCO nanowires with range of 35nm to 100nm are produced abundantly with the use of AAO template with 35nm or 40nm. The superconductivity of metal and oxide-based nanowires are expected to greatly enhance when the product nanowires reach or lower than the coherence length. The coherence length of YBCO is around 3~5 nm. Therefore, while thin YBCO nanowires are produced, their physical and electrical properties are not expected to be differ from the bulk counterpart.