X-RAY DIFFRACTION AS A PROCESS CONTROL TOOL IN SUPERCONDUCTOR APPLICATIONS

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High performance YBCO coated superconductors require that the quality of the tape be monitored in a continuous fashion at selected processing steps, including the fully coated tapes. The manufacturing process consists of several steps during which the buffer layers, a superconductor layer, and the overcoat are deposited sequentially on a nickel alloy tape. The performance of the superconducting tape, as measured by the density of the engineering current, depends strongly on the crystallographic orientation of the YBCO and on texture sharpness which are dictated by the epitaxial relationships between the substrate and all films in the stack. The incorrect stochiometry of YBCO and the presence of compounds generated by interaction between layers in the stack have also a detrimental effect on tape quality. The thickness variations and lack of continuity of the YBCO layer are disqualifying flaws. Due to large lengths of tapes (potentially up to 200 meters) the nondestructive monitoring of the tape quality needs to be done on tapes moving at speeds up to 1cm/s. A design of an x-ray diffraction instrument capable of nondestructive characterization of superconductive tapes through a near real-time monitoring of crystallographic texture and phase composition on moving tapes is presented. The instrument uses an area detector for mapping of selected regions of the reciprocal space. The critical orientations and phase composition of substrate, buffer layers and superconductive layer are monitored individually or simultaneously at sub-second intervals on a tape moving on a reel-to-reel apparatus. A quantitative texture analysis (orientation distribution function) is carried out at locations showing texture variations. The fundamental principles of texture monitoring on multiple layers, flaw delectability limits, and experimental examples of flaw detection, sizing and characterization are presented.