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HTS Coated Cylinders Processed via Alternating Beam Assisted Deposition (ABAD)

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***Abstract*—Recent progress in manufacturing of bi-axially textured buffers on cylinders via ion beam technology is reported. Ultimately, these buffered substrates should allow processing of HTS coated cylinders with small radius.**
It was confirmed by XRD (θ-2θ and φ-scan) that the YSZ [001] direction is normal to the substrate surface and the in-plane misalignment was better than FWHM=9 degrees for the both substrate types. These results were additionally confirmed by X-ray measurements of YBCO films deposited onto these bi-textured buffers.

I. Introduction

HTS coated cylinders as a variant of coated conductors were always attractive because of lossless circumferential currents. Different application fields of coated cylinders as superconducting fault current limiter of resistive and inductive type, field gradiometers, NMR field formers have been listed earlier, and certain deposition techniques (as e.g. inclined substrate deposition) were developed to provide bi-axially textured buffer layer on cylindrical surfaces.

II. Experimental

The bi-textured yttria stabilized zirconia (YSZ) layers on a cylindrical surface were manufactured by an alternating ion-beam assisted deposition technique where the film is periodically exposed to deposition pulses and to etching pulses. As a long sequence of alternations of these two pulses is needed, this method was called “alternating beam assisted deposition” (ABAD).
Two types of substrates were employed: a segment of the sapphire single crystal cylinder with diameter of 12 mm and length of 60 mm and a 100 µm thick stainless steel (CC) tape which simulated metallic cylinder of the same diameter.
Mechanically polished substrates exhibited a roughness of typically 6 nm. The thickness of the textured YSZ layer was 2.5 µm. The sapphire substrates were preliminary covered with an amorphous layer of chemically neutral material in order to prevent non-desirable orientations in YSZ film.

III. Measurement results

The crystalline structure of the films was investigated by X-ray diffraction, see Fig. 1 and Fig. 2.

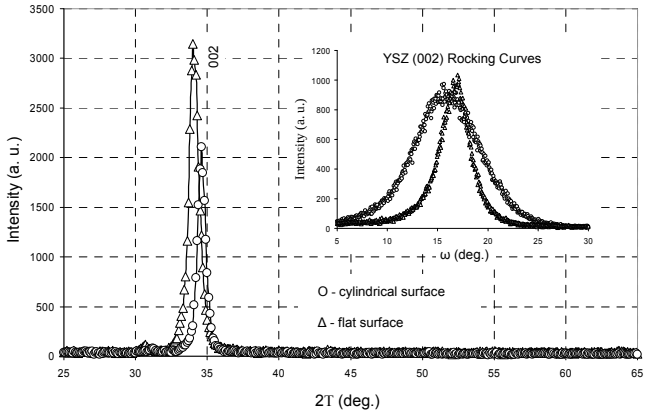

Fig. 1. XRD T-2T patterns and ω-scans (inset) of the ABAD YSZ films grown on cylindrical and flat surfaces.

The T-2T scans yield only (001) reflections of YSZ, which shows that the films on the both types of substrates are purely c-oriented.
The full width at half maximum (FWHM) values of the rocking curves are 7.2° and 3.3°, measured in the longitudinal direction of the cylindrical segment and flat-formed CC tape respectively.

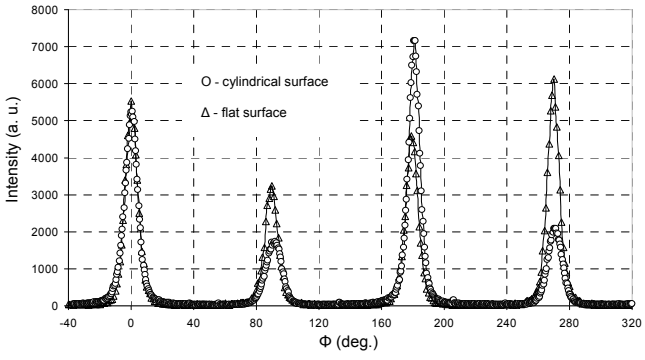

Fig. 2. XRD Φ-scans of the epitaxial YSZ films grown on cylindrical and flat surfaces.

FWHM values of the Φ-scans for both types of substrates are neaby of 9.0°.
The results represent the first success in manufacturing of high-textured YSZ layers on cylindrical surfaces of small diameter using ABAD.