

## **YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7-x</sub> Film with Nanoscale Ba<sub>2</sub>YNbO<sub>6</sub> + Ba<sub>2</sub>YTaO<sub>6</sub> Inclusions for High Magnetic Field Applications**

G. Celentano<sup>1</sup>, F. Rizzo<sup>1</sup>, A. Augieri<sup>1</sup>, A. Angrisani Armenio<sup>1</sup>, A. Mancini<sup>1</sup>, V. Pinto<sup>1</sup>, A. Rufoloni<sup>1</sup>, A. Vannozi<sup>1</sup>, A. Frolova<sup>2</sup>, E. Silva<sup>2</sup>, K. Torokhtii<sup>2</sup>, N. Pompeo<sup>2</sup>, J. L. MacManus-Driscoll<sup>3</sup>, J. Feighan<sup>3</sup>, A. Kursumovic<sup>3</sup>, A. Meledin<sup>4</sup>, G. Van Tendeloo<sup>4</sup>

<sup>1</sup> ENEA, Frascati Research Centre, Via E. Fermi, 45 – 00044 Frascati, Italy,

<sup>2</sup> Engineering Department, Roma Tre University, Via Vito Volterra 62, 00146, Rome, Italy,

<sup>3</sup> University of Cambridge, Department of Materials Science and Metallurgy, 27 Charles Babbage Rd., Cambridge, CB3 0FS, U.K,

<sup>4</sup> University of Antwerp, EMAT Research Group, Groenenborgerlaan 171, 2020 Antwerp, Belgium

Email: [giuseppe.celentano@enea.it](mailto:giuseppe.celentano@enea.it)

**Abstract** - Structural and transport properties of YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7-x</sub> films obtained by pulsed laser deposition with incorporated Ba<sub>2</sub>YTaO<sub>6</sub> and mixed Ba<sub>2</sub>YTaO<sub>6</sub> and Ba<sub>2</sub>YNbO<sub>6</sub> (Ba<sub>2</sub>Y(Nb/Ta)O<sub>6</sub>) double perovskite secondary phases are investigated in an extended temperature and magnetic field range. The effects of the different doping and the film growth kinetics on the microstructure were studied. The Ba<sub>2</sub>YTaO<sub>6</sub> truncated nano-sized columns are modified into continuous columns in case of mixed Ba<sub>2</sub>Y(Nb/Ta)O<sub>6</sub> incorporation. High growth rates promote a peculiar microstructure characterized by the formation of Ba<sub>2</sub>Y(Nb/Ta)O<sub>6</sub> splayed columns decorated by Y<sub>2</sub>O<sub>3</sub> nanoparticles, very effective for flux pinning in a wide temperature and magnetic field range. Based on  $J_c$  measurements, the vortex pinning behaviour of Ba<sub>2</sub>Y(Nb/Ta)O<sub>6</sub> films are discussed and compared with BaZrO<sub>3</sub> doped films showing the high potentiality of mixed Ba<sub>2</sub>Y(Nb/Ta)O<sub>6</sub> inclusions in perspective of the applications of REBa<sub>2</sub>Cu<sub>3</sub>O<sub>7-x</sub> coated conductors in a broad range of conditions.

**Acknowledgments** - This work was partially supported by EUROTAPES, (FP7/ 2007-2013) under Grant Agreement no. 280432 and by the Euratom research and training programme 2014-2018 under grant agreement N° 633053, AWP15-ENR-01/ENEA-08

**Keywords (Index Terms)** – YBCO films, PLD technique, artificial pinning centers, vortex pinning properties.

IEEE CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), November 2019.

Received October 21, 2019; selected October 24, 2019. Reference STP660; Category 5.

Invited presentation 2-MO-FP1-O11 given at EUCAS 2019, September 01 - 05, 2019, Glasgow (UK).