Evolution of Electronic States in Epitaxial YBCO Thin Films with Calcium Doping by Angle-Resolved Photoemission Spectroscopy

Anjana Krishnadas[a], Yuita. Fujisawa[a], Markel Pardo-Almanza[a], Kohei Yamagami[a,b], Yukiko Obata[a] , Yoshinori. Okada[a]

[a]*Quantum Materials Science Unit, Okinawa Institute of Science and Technology (OIST), Okinawa 904-0495, Japan.*

[b]*Japan Synchrotron Radiation Research Institute, Hyogo, 679–5198, Japan.*

Keywords: High temperature superconductors, ARPES, epitaxial thin film growth, heterostructures.

Abstract

Cuprates are among the most intriguing strongly correlated systems, exhibiting a variety of complex electronic phases. Studies on the nature of the Fermi surface (FS) and the electronic properties of HTSCs such as $YBa_2Cu_3O_{7-d}$ (YBCO) have also gained attention thanks to powerful experimental technologies [1,2] and advances in thin film growth [3,4]. The development of film-based heterostructures is a new major challenge.

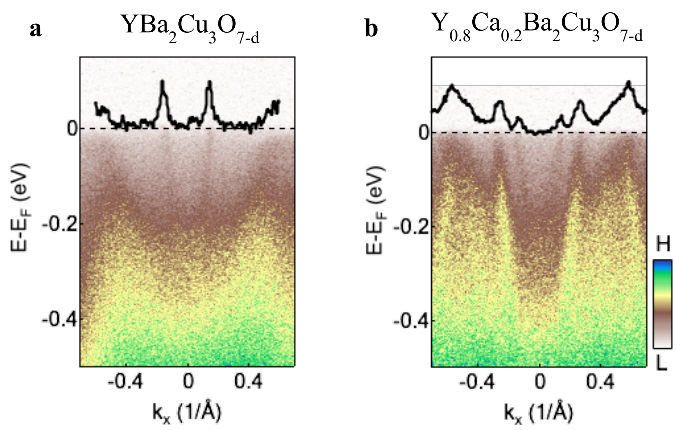

Figure 1. (a) ARPES intensity image of a near-optimally doped YBCO and (b) 20% Ca-doped thin film at the antinodal region obtained at 15 K, with a laboratory-based He-II light source (40.8 eV). The film was grown on a $LaAlO_3(001)$ substrate.

In this work, we present an *in-situ* ARPES study on the calcium doping evolution of electronic states on the surface of YBCO epitaxial films grown by pulsed laser deposition. The ARPES of undoped YBCO shows the typical electronic structure of an optimally doped CuO_2 plane and a series of one-dimensional bands originating from the CuO chains, while the 20% Ca-doped YBCO thin film additionally shows a second chain state as shown in Figure (1 b). When YBCO is partially doped with Ca, we also observe the appearance of band folding due to possible surface reconstructions. The careful tuning of the surface electronic states, together with a high Tc, as well as a larger coherence length along the c-axis, thus makes YBCO a good candidate as an HTSC substrate for *in-situ* heterostructures.

References:

[1]. H. Iwasawa *et al.*, *Phys. Rev. B.* 99 (14), 140510 (2019).
[2]. H. Iwasawa *et al.*, Ultramicroscopy, Volume 182, Pages 85-91 (2017).
[3]. Wu, Z.-B. *et al*., *Phys. Rev. Mater.* 4, 124801 (2020).
[4]. Y. Sassa et.al*., Phys. Rev. B* 83, 140511(R) (2011).