# Supplemental Material for:

# Probing localized strain in solution-derived $YBa_2Cu_3O_{7-\delta}$ nanocomposite thin films

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## Strain imaging in YBCO by Low Angle Annular Dark Field:

The combination of both high-angle with low-angle ADF is an easy and straightforward method to visualize the nanoscale lattice deformations present in the YBCO matrix associated to defects and nanoparticles. **Fig. SM1(a)** and **SM1(b)** show the simultaneously acquired HAADF and LAADF images of a pristine YBCO film, respectively. In HAADF mode, the dark stripes running parallel to the (001) YBCO plane evidences the presence of planar defects in the film (**Fig. SM1(a)**). However, these planar defects appear brighter in LAADF (**Fig. SM1(b)**). Notice that the bulk of the film, which is free of defects, presents a homogenous contrast. On the other hand, the YBCO with 6% mol BYTO nanocomposite film shows a higher density of defects as well as a homogeneous distribution of BYTO nanoparticles at both the matrix and interface, **Fig. SM1(c)** and **SM1(d)**.

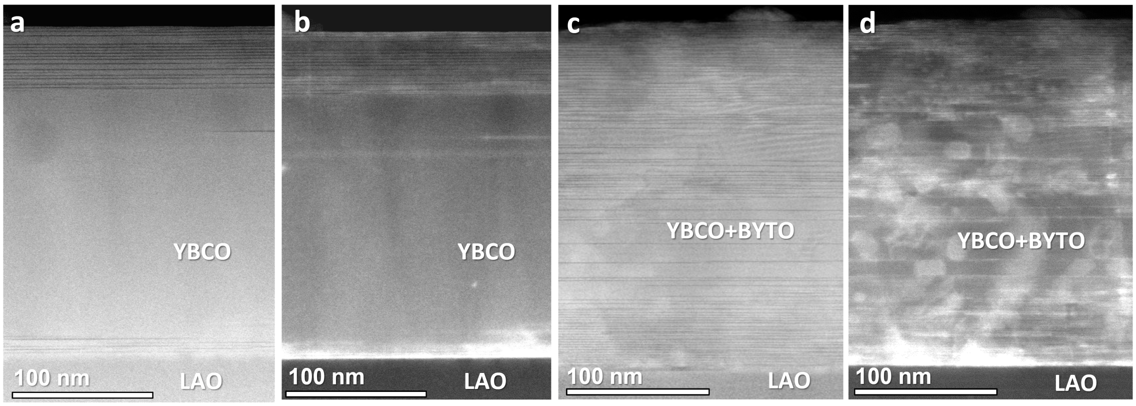


FIG SM1. Comparison of the microstructure between a pristine YBCO film and YBCO-6% mol BYTO nanocomposite films. (a)-(b), and (c)-(d) are the simultaneously acquired HAADF and LAADF low magnification images, respectively.

Although the strain fields emerging from an isolated intergrowth within a defect-free region can be easily identified by LAADF imaging, things may be more complicated when multiple defects interact with each other. **Fig. SM2(a)** and **SM2(b)** show two HAADF and LAADF images, respectively, of a region with several staggered Y124 intergrowths. As observed, the most intense contrast in the LAADF image comes from the regions where the strain fields of nearby partial dislocations interact, strongly distorting the surrounding YBCO planes. A good example of this is the region marked by arrows. Other minor contrast variations compared to the strain-free lattice might be due to the presence of twin boundaries.

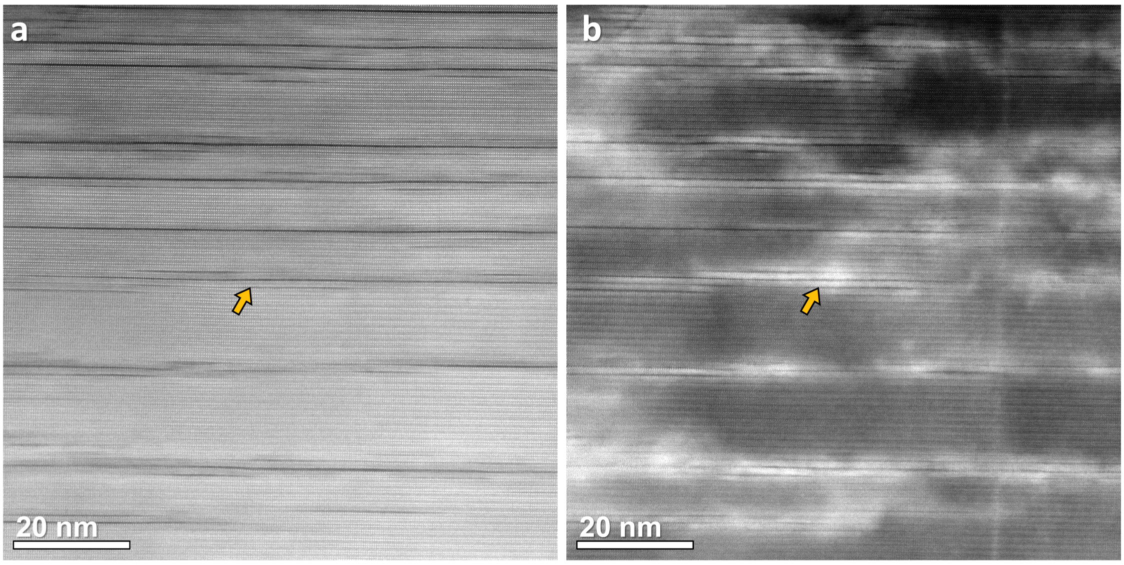


FIG SM2. HAADF and LAADF images, (a) and (b) respectively, of a YBCO region with several staggered Y124 defects. The most intense contrast in the LAADF image comes from the interaction of the partial dislocations associated to the intergrowths. The arrows point to an interaction between the strain fields associated to two adjacent Y124 partial dislocations.

Y124 partial dislocation strain analysis:

Lattice deformation can be obtained and quantified from high-resolution images using the geometrical phase analysis (GPA) tool. The strain analysis of a dislocation is shown in **Fig. SM3(a)-(c)**. **Fig. SM3(a)** is the HAADF image, and **Fig. SM3(b)** and **SM3(c)** are the $\varepsilon_{yy}$ and $\varepsilon_{xx}$ deformation maps showing the lattice displacements along the $<001>_{YBCO}$ and $<100>_{YBCO}$ directions, respectively. Lattice deformation is represented by a color scale which indicates the difference in percentage compared to the reference lattice. The reference lattice is marked in the HAADF image corresponding to a single YBCO unit cell as it is the unity element repeated in the crystal. **Fig. SM3(d)** corresponds to the out-of-plane ($\varepsilon_{yy}$) profiles taken from the reference lattice (green line and green arrow in (b)) and near the dislocation (red line and red arrow in (b)). The blue arrow points the dislocation plane and the inset at the bottom shows the alternation of the Ba and Y-perovskite blocks in the YBCO. As observed, comparing both profiles, tensile deformations near the dislocation core are confined between Cu-O chain layers while compressive strains are confined between $CuO_2$ superconducting planes. **Fig. SM3(e)** corresponds to the in-plane ($\varepsilon_{xx}$) profiles taken along the dislocation plane (green line, and green arrow in (c)), above the dislocation plane (red line, and red arrow in (c)) and below the dislocation plane (blue line, and blue arrow in (c)). The orange arrow points the dislocation plane. As observed, tensile deformation are located at the dislocation core.

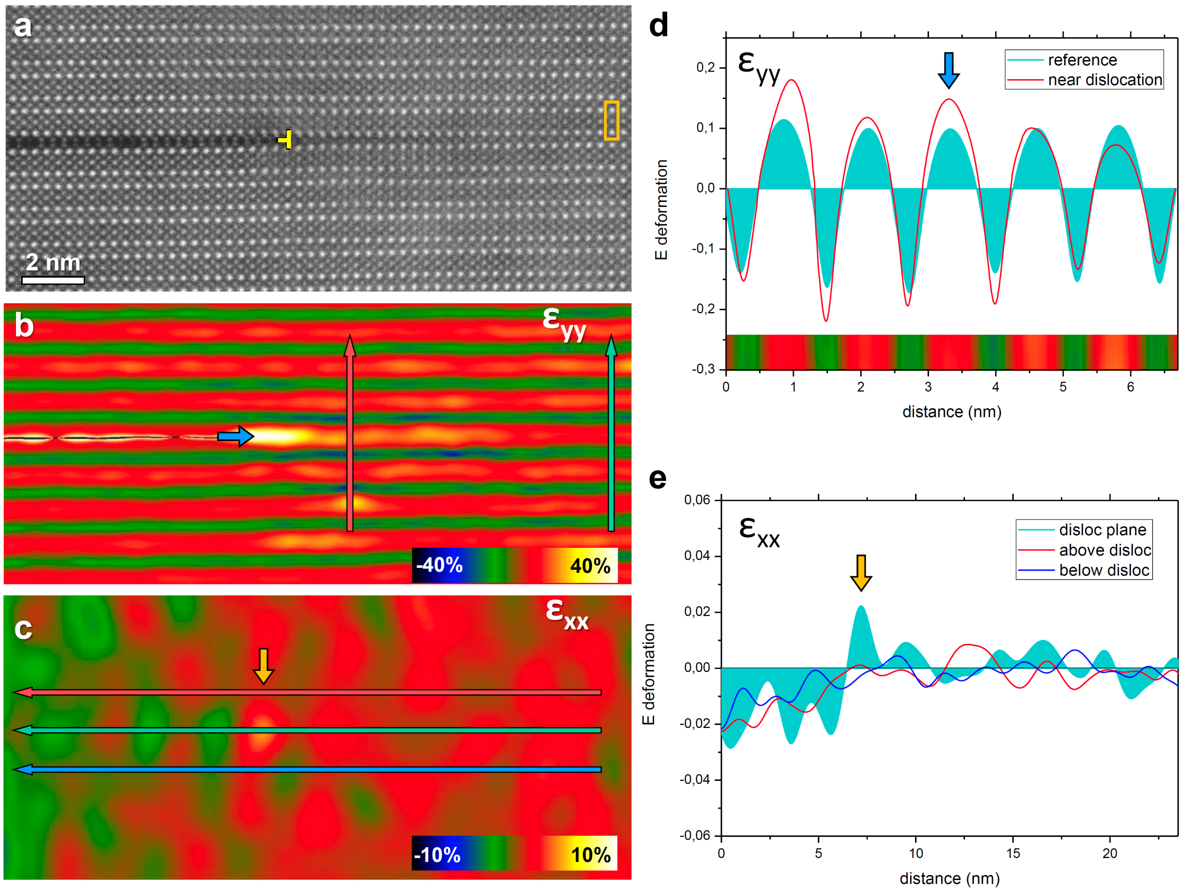


FIG SM3. (a) HAADF image of an Y124 partial dislocation within the YBCO matrix. GPA $\varepsilon_{yy}$ (b) and $\varepsilon_{xx}$ (c) deformation maps along the <001>YBCO and <100>YBCO directions. The Bragg reflections taken for computing the images are the {100} and {003}, respectively. The marked region in the HAADF image is the reference lattice. (d) Line profiles taken from the out-of-plain deformation map ($\varepsilon_{yy}$) at the reference area (green line) and near the dislocation core (red line). (e) Line profiles taken from the in-plain deformation map ($\varepsilon_{xx}$) at the dislocation plane (green line) and above and below the dislocation plane (red and blue line, respectivedly).