**3D Visualization of Phase-Ordering and Lattice Strain**

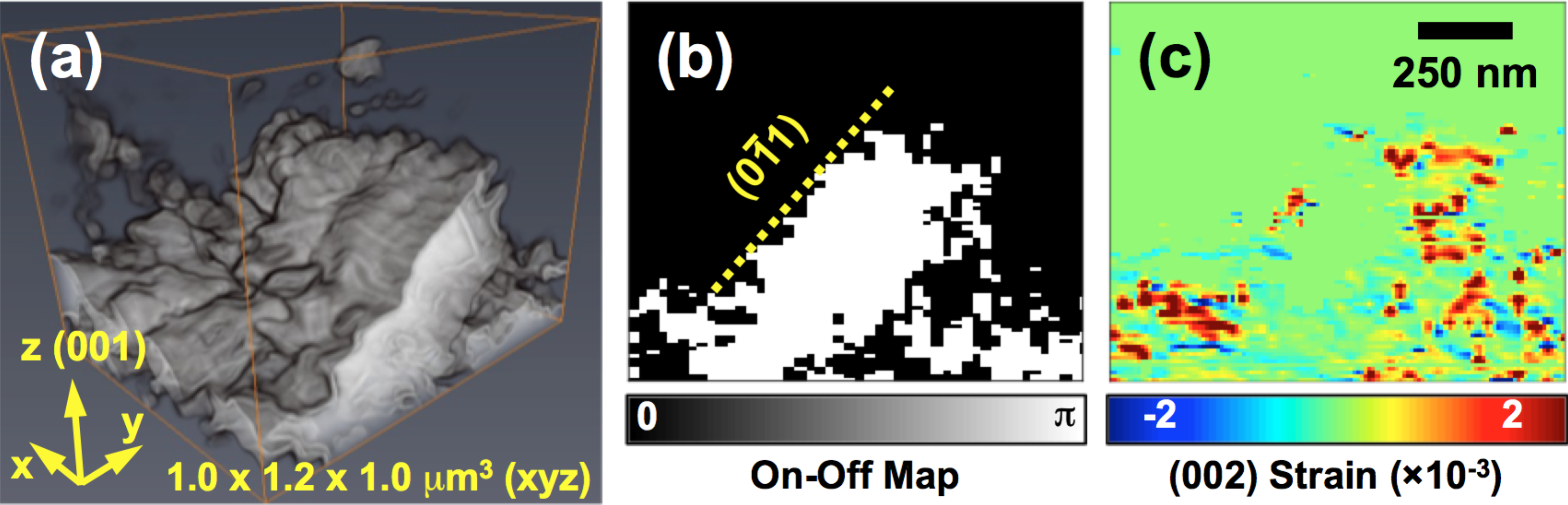
**in an Fe-Al Alloy by Coherent X-ray Bragg Ptychography**

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Intermetallic alloys are essential in human life because of their widespread applications, e.g. in steel, in the refining, and in aeronautics industries. Fe-Al alloys have attractive physicochemical properties, e.g. remarkable oxidation resistance and rich magnetic properties [1] and novel FeAl nano-twinned alloys combine lightweight with steel-like strength [2]. Depending on composition and temperature, binary alloys show several chemically ordered phases and the macroscopic properties can be strongly affected. For a deeper understanding of phase-ordering, we performed x-ray Bragg ptychography [3,4] on a B2 phase FeAl alloy. FeAl alloys display ordered phases where the atoms organize on sublattices resulting in the emergence of otherwise forbidden superlattice reflections [5,6]. The degeneracy of the ordered structures results in domain boundaries that, in addition to the general strain of the lattice, will give a phase shift depending on which reflection is probed. We investigated the lattice strain associated with phase ordered domains by imaging the (002) fundamental Bragg and the (001) superlattice reflections of Fe55Al45 in the B2 phase [7]. Using the (002) data, the (001) images could be normalized for lattice strain and APDs visualized in 3D for the first time.



**Figure 1**: (a) 3D APD image calculated from (001) and (002) phase images ((002) -(001)/2, where (001) and (002) correspond to the (001) and (002) phase images, respectively). The empty area corresponds to one phase of ordered domains and the gray colored area corresponds to another. The length of the axis arrows is   
250 nm. (b, c) 2D cuts showing a domain in binary representation (b) and the corresponding lattice strain (c).

**References**

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