Identification and characterization of complex nanostructures have always been a challenge. Real-space imaging through transmission electron microscopy is the conventional tool of choice to study the internal structure of materials, but it cannot be realized routinely with atomic resolution even using state-of-the-art aberration corrected microscopic techniques because of the large dimensions of the nanostructures involved in many cases. In general, the atomic resolution electron microscopy is also a destructive structural characterization technique for complex nanostructures, due to the need for preparing ultrathin cross-sectional samples, yet the knowledge on the structure of intact complex nanostructures maybe important as it could be the key behind the enhanced physical properties of the nanostructures. Non-destructive characterization of the nanostructures can be achieved through real-space electron tomography, however it often suffers from a ‘missing wedge’ problem [1]. In this paper [2], we explore the inverse relationship between the real-space nanostructure and their diffraction to demonstrate an non-destructive study of the internal structure of a boron-rich nanowire by reconstruction of the three-dimensional diffraction. Here we will show that the analysis of 3D diffraction intensity distribution allows us not only to identify the cyclic twinned structure directly, but the technique also reveals quantitatively the orientation relationship of the internal crystallites and information about deformation and defects associated with the internal strain relaxation, all non-destructively.


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Fig. 1: (a) The intensity distribution around (112) and (113) reflections from a boron carbide five-fold twinned nanowire shown at the lower left corner. The magnified view of the 3D (b) distribution of the (112) reflections (b) and the projected intensity (b) in the Ω plane defined in (a) compared with the calculated 2D intensity map (d).