Ptychographic X-ray Tomography of Silk Fiber Hydration

Studying noninvasively the internal nanoporous structure of a single Tussah silk fiber under different humidity conditions, we demonstrate for the first time the feasibility of in-situ ptychographic tomography. The resulting 3D images of the silk fiber interior, obtained at both dry and humid conditions, yield quantitative information about the spatial density variations in the form of detailed maps of the size, shape, and orientation distributions of the nanopores inside the silk fiber, revealing that the fiber swells anisotropically in humid conditions, with the expansion taking place solely normal to the fiber axis. Exploiting quantitative information on the fiber’s electron density, hydration was found to proceed through interaction with the silk protein rather than filling of pores.

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