

Supplementary information

Directional Growth and Reconstruction of Ultrafine Uranium Oxide Nanorods within Single-Walled Carbon Nanotubes

Luyao Zhang^a, Kun Wang^a, Xin Zhao^a, Guoping Yang^b, Yulong Jiang^a, Feng Yang^{*a}

^aDepartment of Chemistry, Southern University of Science and Technology, Shenzhen, Guangdong 518055, China

^bJiangxi Key Laboratory for Mass Spectrometry and Instrumentation, Jiangxi Province Key Laboratory of Synthetic Chemistry, East China University of Technology, Nanchang 330013, China

*Email: yangf3@sustech.edu.cn

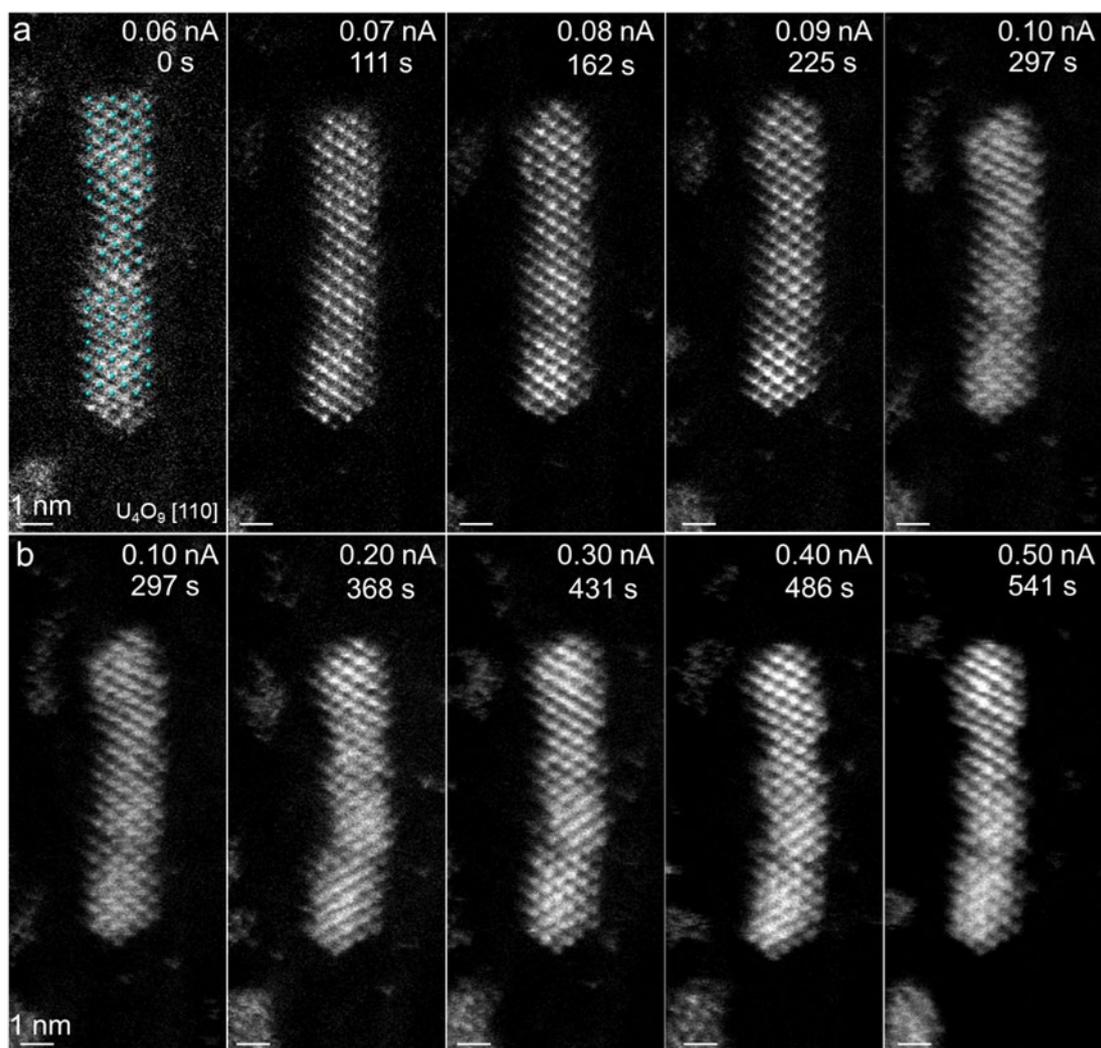


Figure S1. Electron beam intensity sequence with 0.01 nA increments (a) and 0.1 nA increments (b) STEM images of in-situ observation of U_4O_9 within SWCNTs.

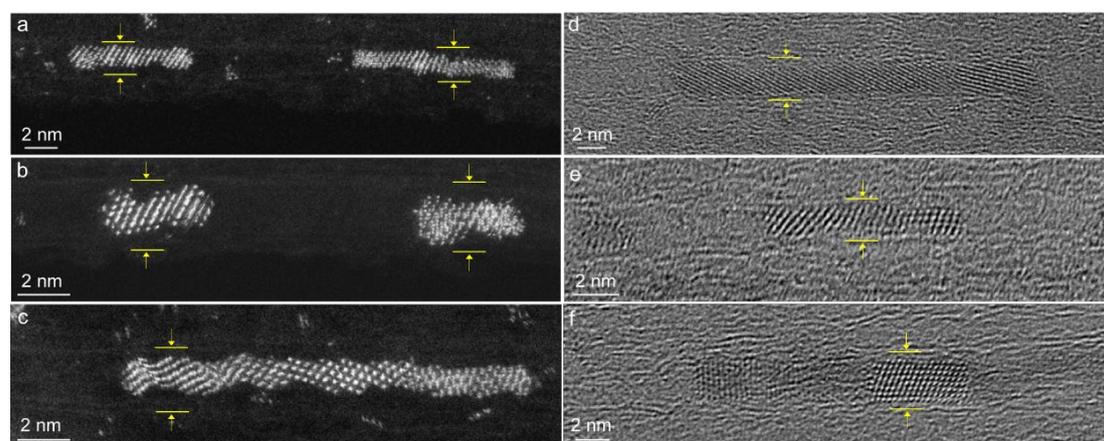


Figure S2. The contrast-modified HAADF-STEM and HRTEM images of $U_4O_9@SWCNT$ with tube wall visible. The tube wall is marked by yellow arrows.

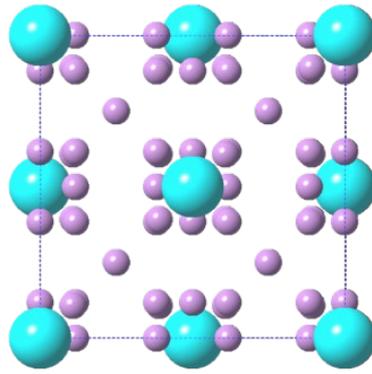


Figure S3. The atomic model of the U_4O_9 unit cell (ICSD: 40259, space group $F\bar{4}3m$), with U in blue and O in purple.

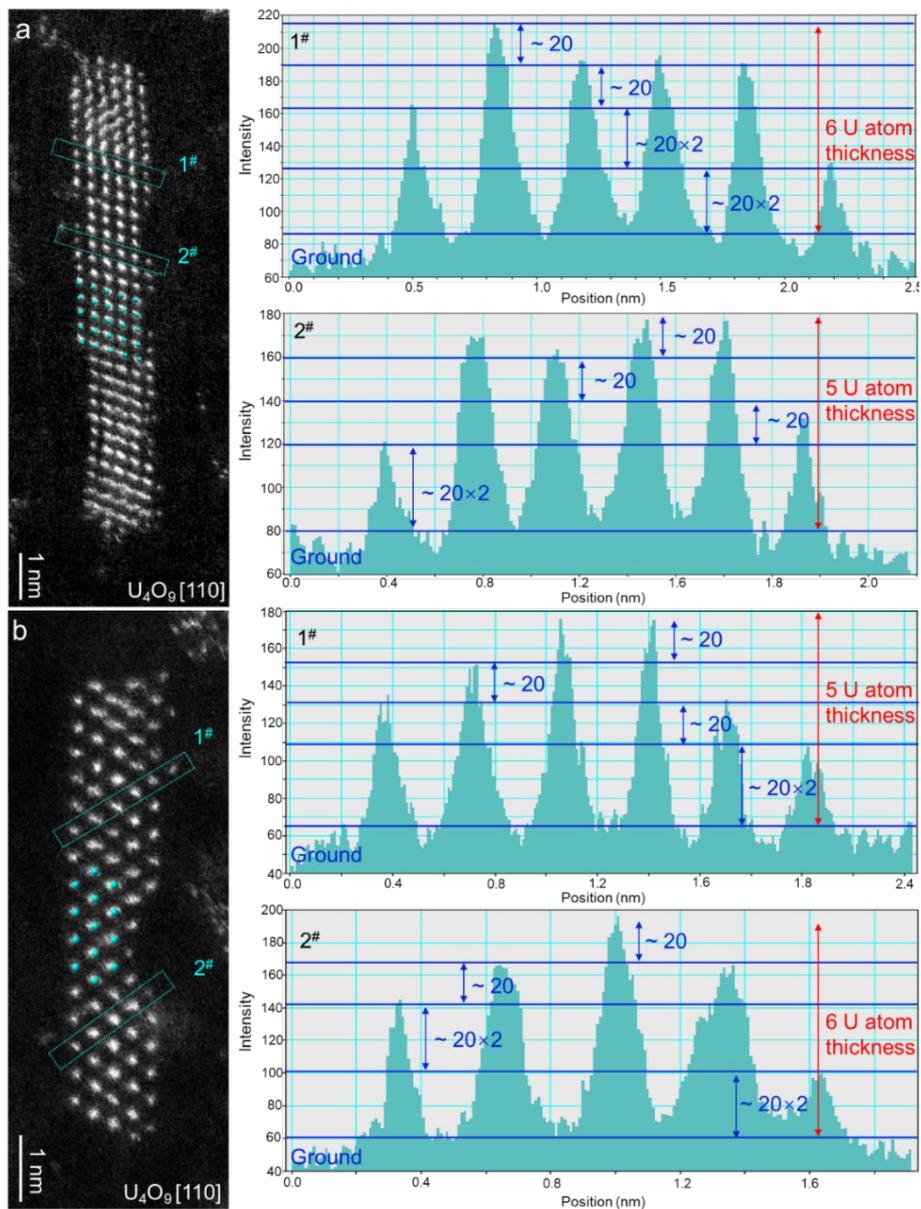


Figure S4. Quantitative analysis of U_4O_9 thickness. HAADF-STEM images and corresponding ADF intensity profiles of atom columns marked in STEM images.

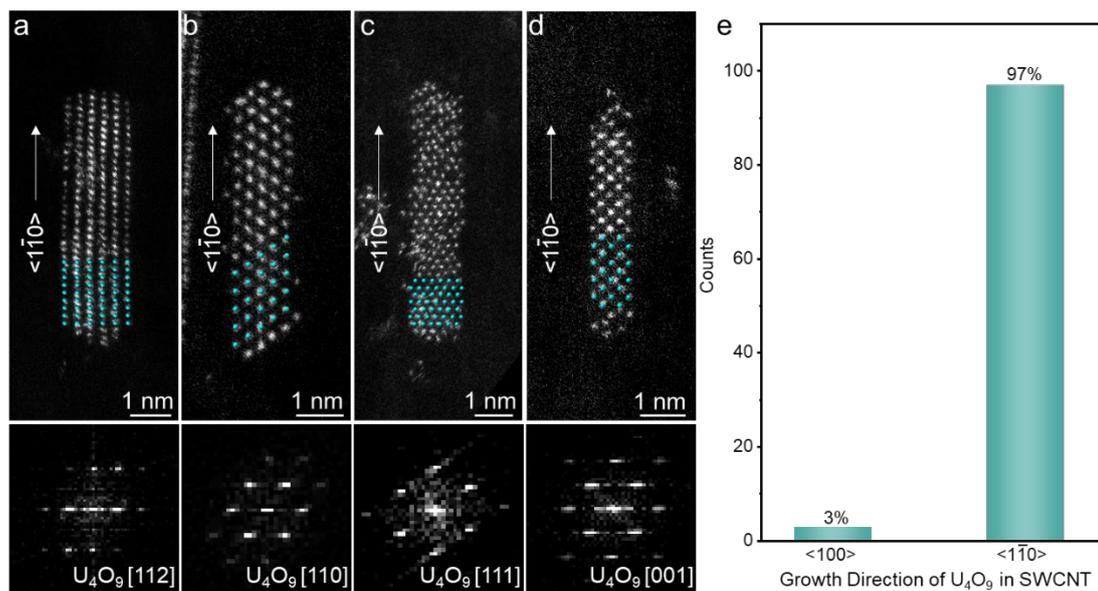


Figure S5. a-d, Ex-situ HAADF-STEM images of U₄O₉ nanorods confined in SWCNT prepared by annealing at 600 °C in tube furnace. e, Statistics of growth directions of U₄O₉ nanorods along the SWCNT axis based on STEM image analysis.

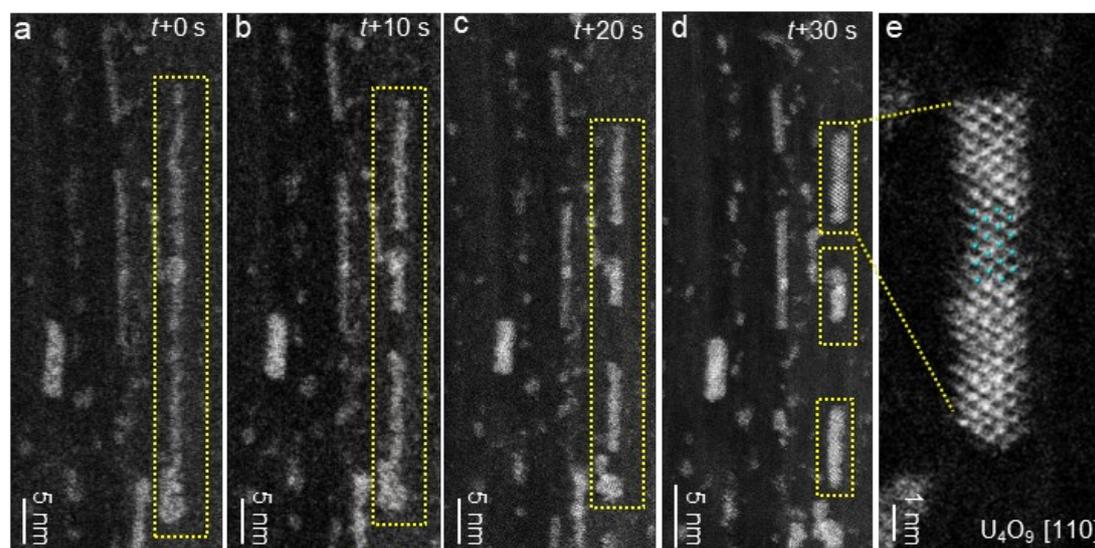


Figure S6. The nucleation process at a low magnification.

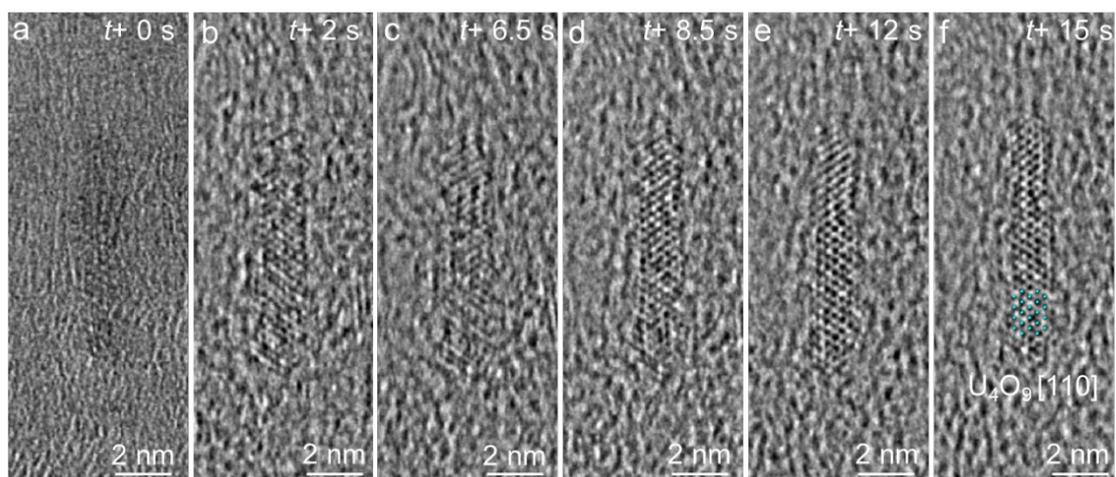


Figure S7. a-f, Time-sequential HRTEM images of the growth process of U_4O_9 nanorods in SWCNTs stimulated by TEM e-beam. The atomic structure of U_4O_9 (with O atoms invisible) is superimposed in (f).

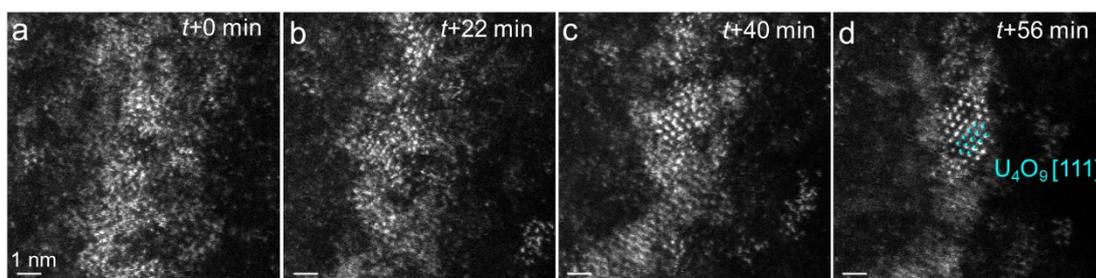


Figure S8. The nucleation process of U_4O_9 on outer surface of SWCNTs. Electron beam intensity: 0.06~0.07 nA.

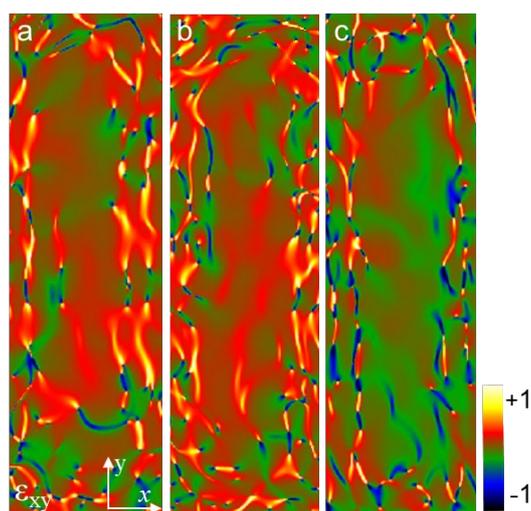


Figure S9. a-c, The corresponding shear strain maps (ϵ_{xy}) from Geometric phase analysis (GPA) of the U_4O_9 nanorods in Figure 3c-e, and the color variation from black to yellow indicates the variation of shear strain values from -1 to 1.

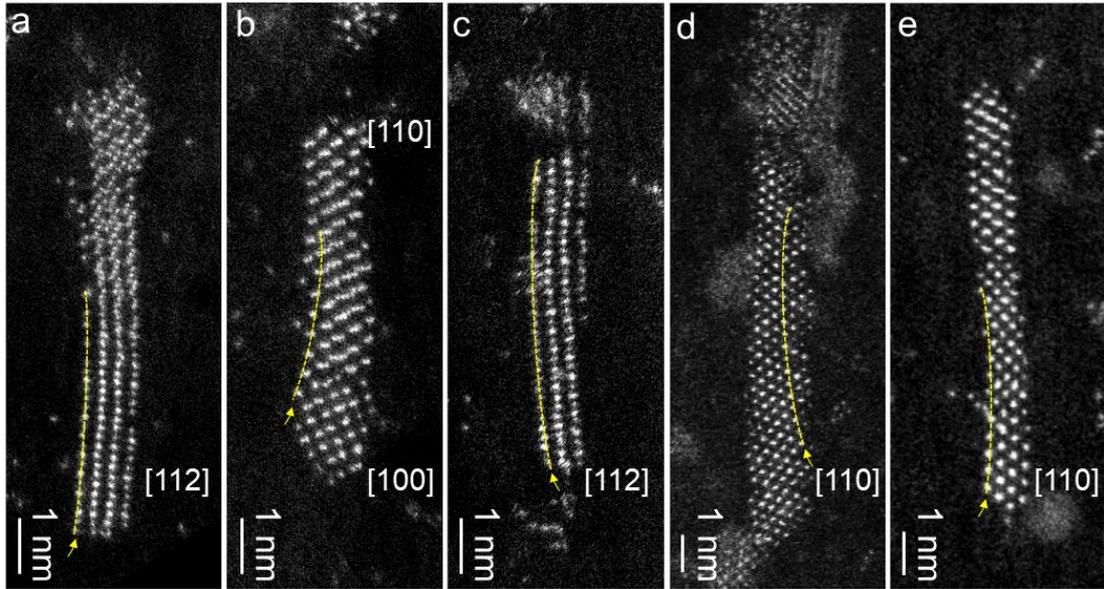


Figure S10. More HAADF-STEM images of U_4O_9 nanorods with bent lattice plane. The dashed curves serve as guides to the eyes only.

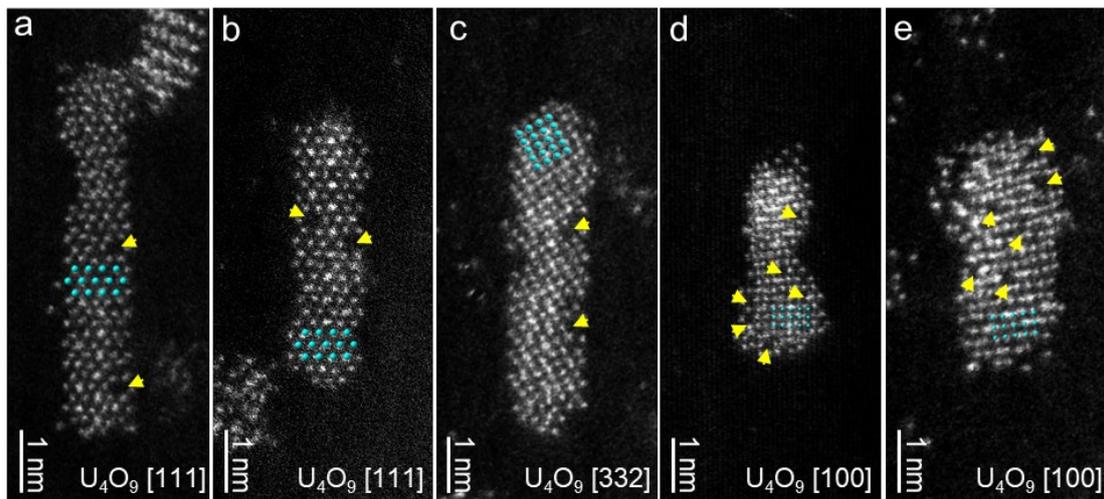


Figure S11. Lattice planes with vacant U column (marked by arrows) in the body of U_4O_9 nanorods.

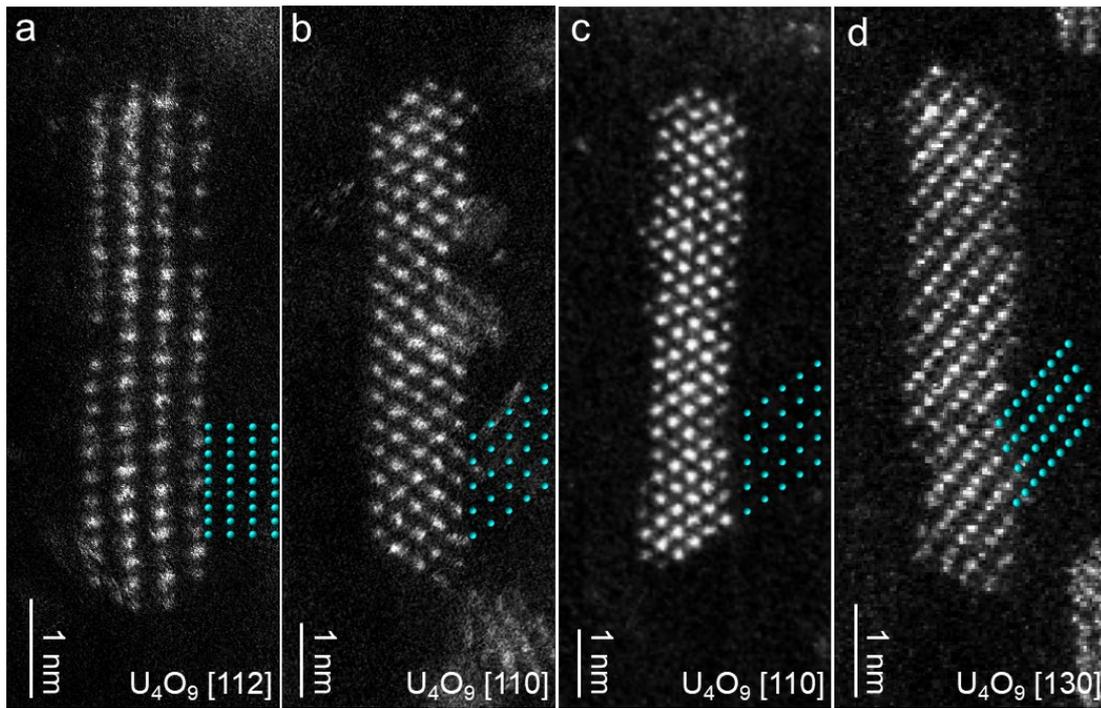


Figure S12. Lattice planes without vacant U column in the body of U_4O_9 nanorods.

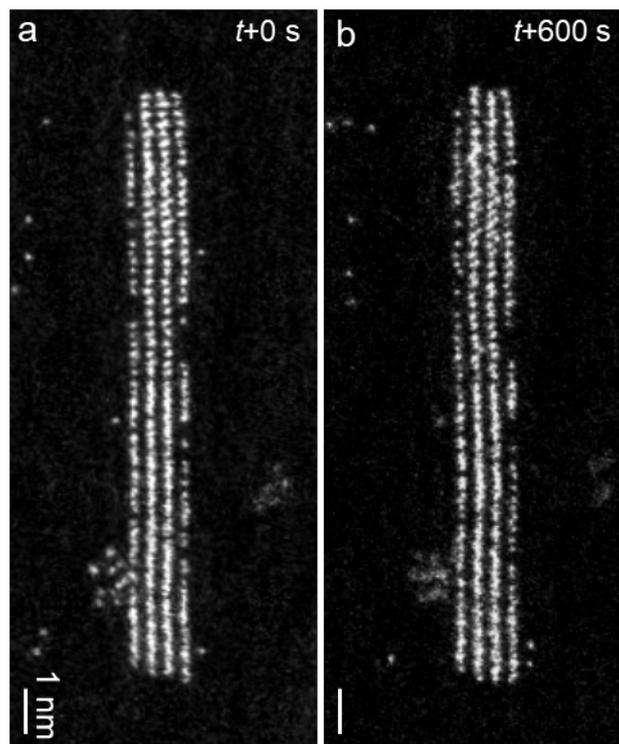


Figure S13. Stability of U_4O_9 nanorods under the STEM e-beam irradiation.

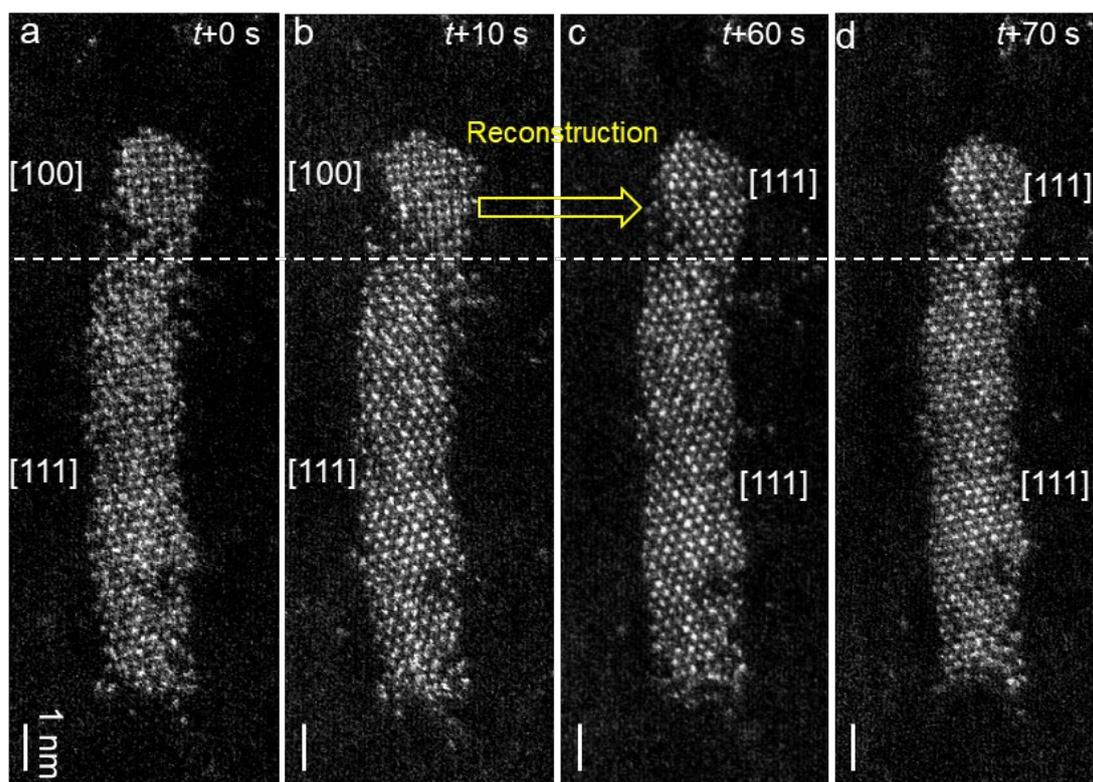


Figure S14. Time-sequential HAADF-STEM images of reconstruction process of U_4O_9 nanorod.