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Strong Metal-Support Bonding Enhanced Thermal Stability in Au-Al_2O_3 Core-Shell Nanowires Characterized by *in situ* Transmission Electron Microscopy

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Deposition conditions of nanowires by He nanodroplet method.

Helium droplets were generated by supersonic expansion of He gas (99.9999%, chromatographic grade, Airgas Inc.) through a Pt nozzle (6.4 μm in diameter) with a stagnation pressure of 20 bar into a vacuum chamber with a base pressure of 2.9×10^{-8} torr. The nozzle was cooled via a closed cycle He compressor down to 4.5 K. A 0.05 cm skimmer, located at 1.7 cm in front of the nozzle, produced a diverging beam of helium droplets. After the skimmer, the beam was directed through a vacuum chamber with a base pressure of 8.6×10^{-9} Torr and equipped with up to three effusive ovens. At 4.5 K and 20 bar, helium droplets each containing ~ 2×10^{10} He atoms were produced and traveled above effusive ovens loaded with Al and Au that were heated at 1375 and 1575℃, respectively. The Al and Au atoms condensed into NWs within the He droplets and were carried to the TEM grids with Si_3N_4 windows and Si_3N_4/Si where the He droplets evaporated, leaving behind the nanowires.

TEM/STEM Characterization

TEM images were collected at 200 kV using JEOL JEM2100F. *In situ* scanning transmission electron microscopy (STEM) and EDS maps were acquired by FEI Talos F200X at 200 kV with an extra-bright electron source and a four-quadrant EDS detector.

XPS Characterization

X-ray photoelectron spectroscopy (XPS) spectra were obtained by a Kratos Axis Ultra DLD spectrometer with nonmonochromatic Al Kα radiation (1486.6 eV) at pass energy of 20. The anode voltage and emission current of X-ray gun were 12 kV and 20 mA, respectively.

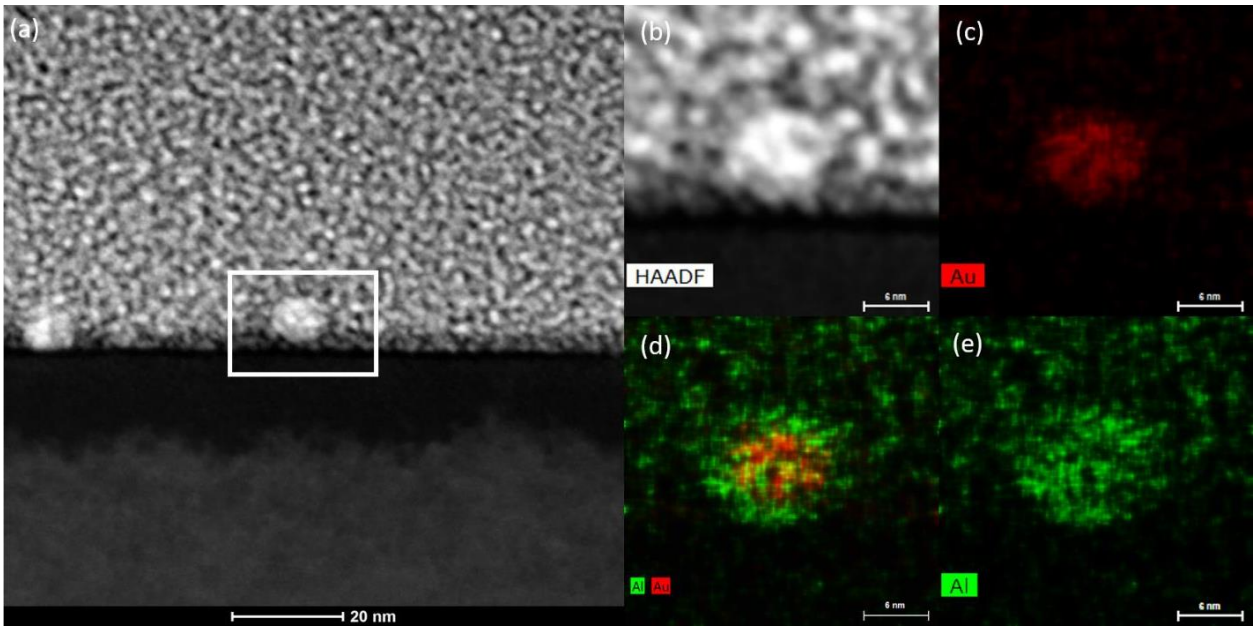

Figure S1. (a): STEM image of a single Au-Al_2O_3 nanowire (cross section view). (b): EDS scanned area highlighted in (a) highlighted by white rectangular. (c) – (e): EDS maps of Au, Au-Al combined and Al signals. Additional FIB and STEM experiments will be conducted to acquire HAADF image of Au with crystal lattice pattern in the future.

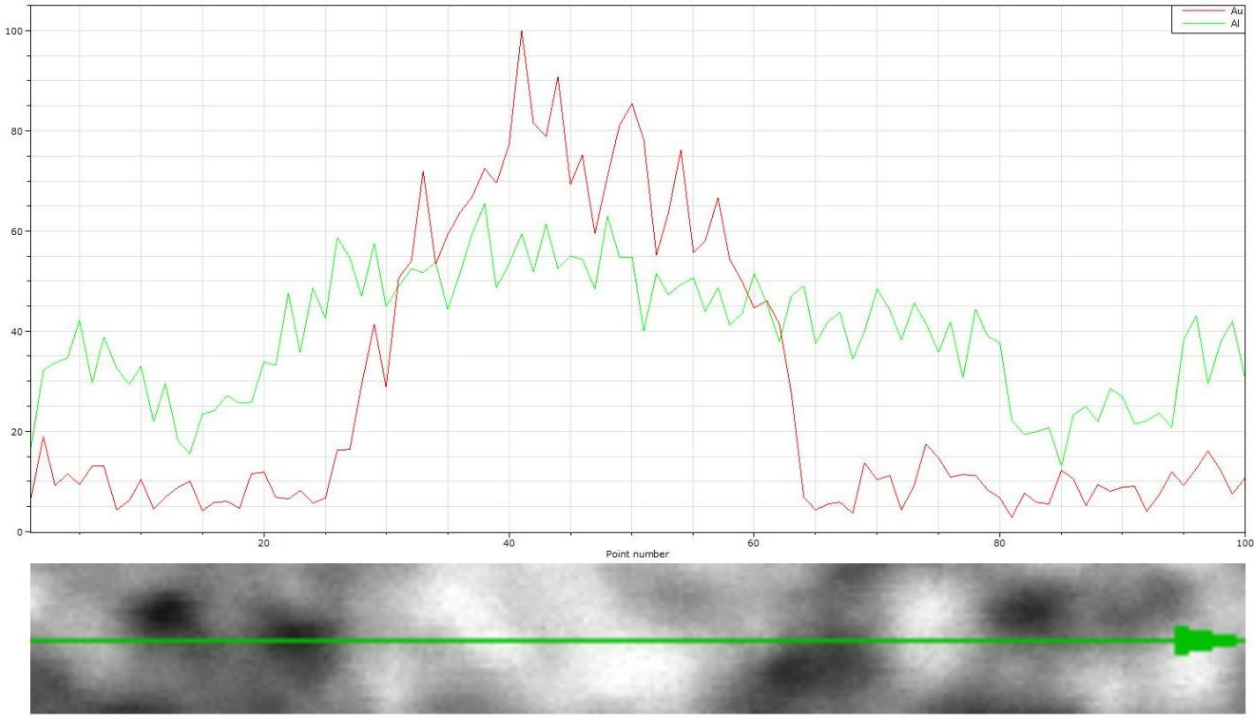

Figure S2. EDS line scan results of nanowire in Figure S1. Au signals (red) were surrounded by Al signals (green), which confirmed the core-shell structure of Au-Al_2O_3 nanowire. The scanned direction is highlighted by the green line in the image under data graph.

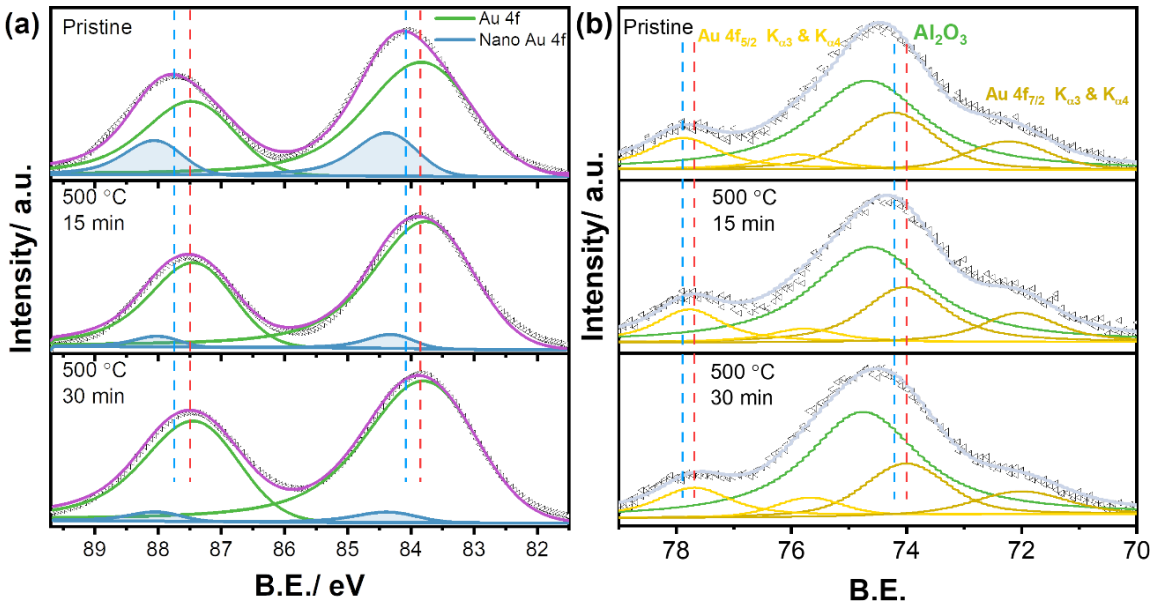

Figure S3. *In situ* XPS heating results of Au and Au-Al_2O_3 nanowires. (a): XPS peaks of Au element. (b): XPS peaks of Al element and Au satellites.