Sub-Two Nanometer Single Crystal Au Nanowires

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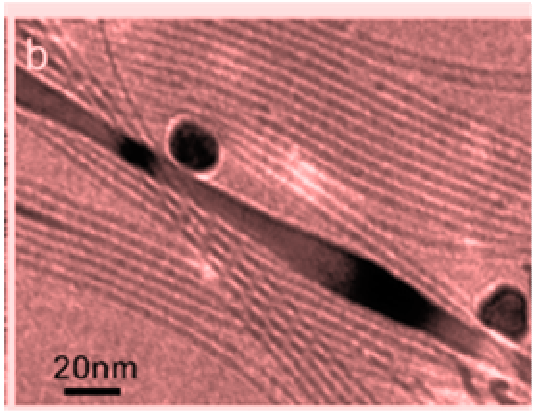

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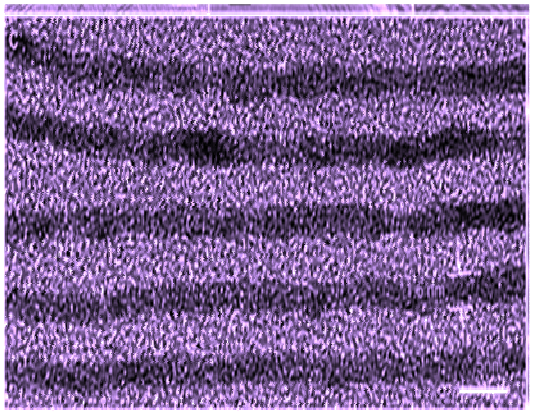

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Introduction

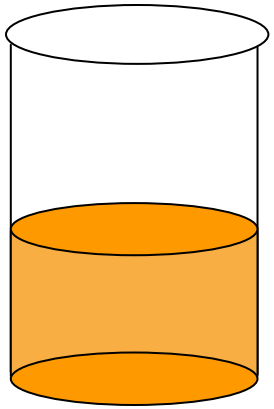
- Application of 1D noble metal nanostructures ⟶ Nano connectors in electronic devices and sensors.

- Various synthetic approaches⟶ Template assisted synthesis, surfactant mediated growth, polyol synthesis (Y. Xia), etc.

About the paper

- A simple solution phase method for the production of high quality ultrathin Au nanowires with uniform diameter of approximately 1.6 nm and length up to ~4 μm.

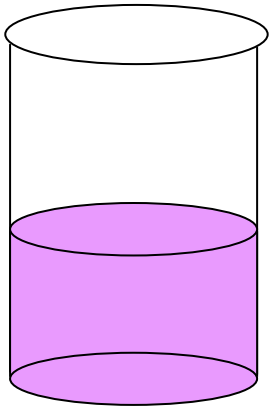
Experimental



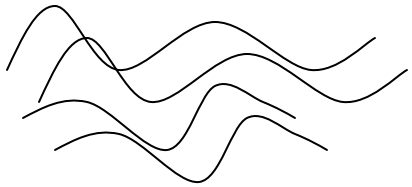
0.2 mmol $HAuCl_4 \cdot 3H_2O$
+
20 mL oleylamine

25 ^{0}C

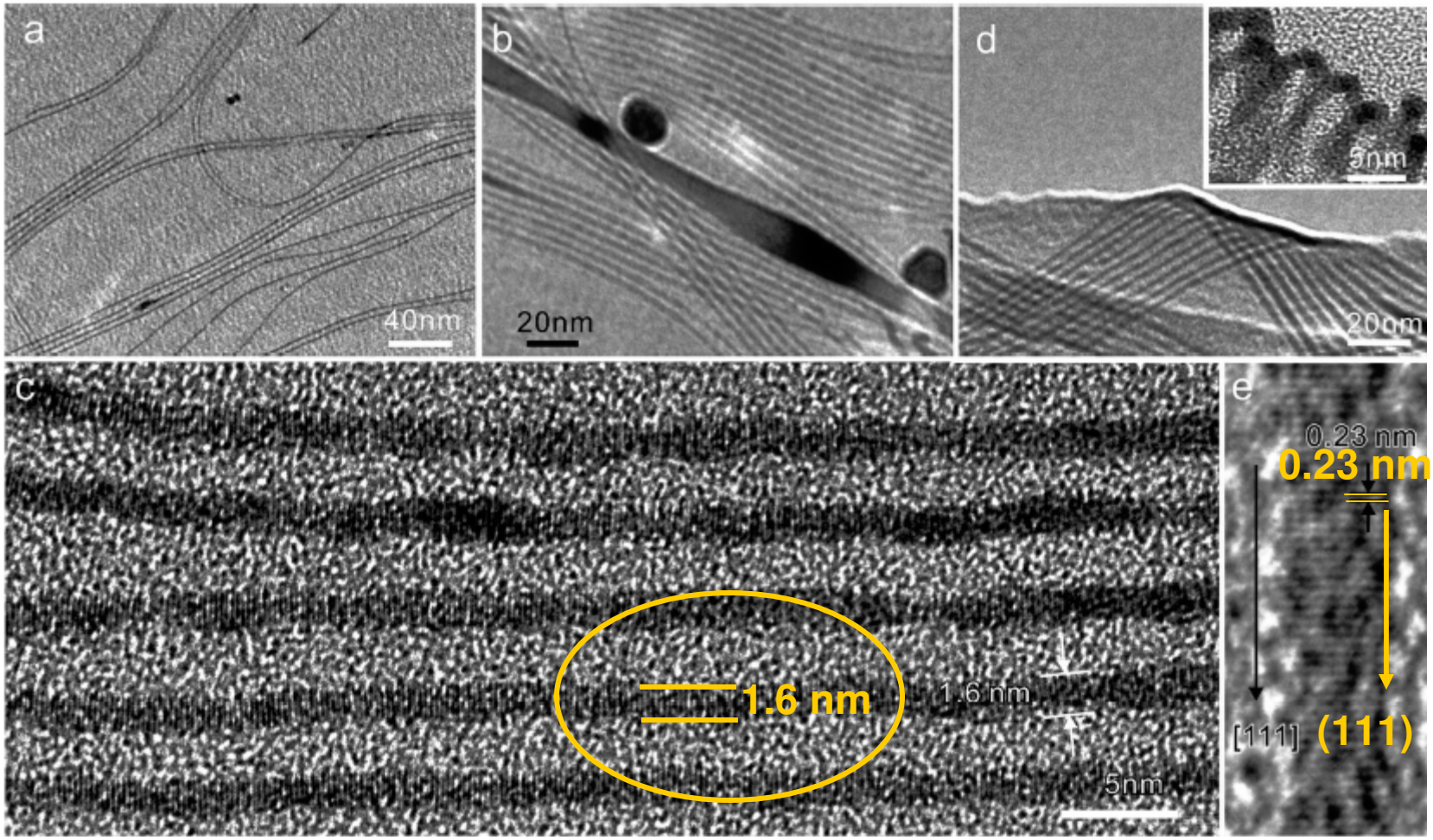
4 Days



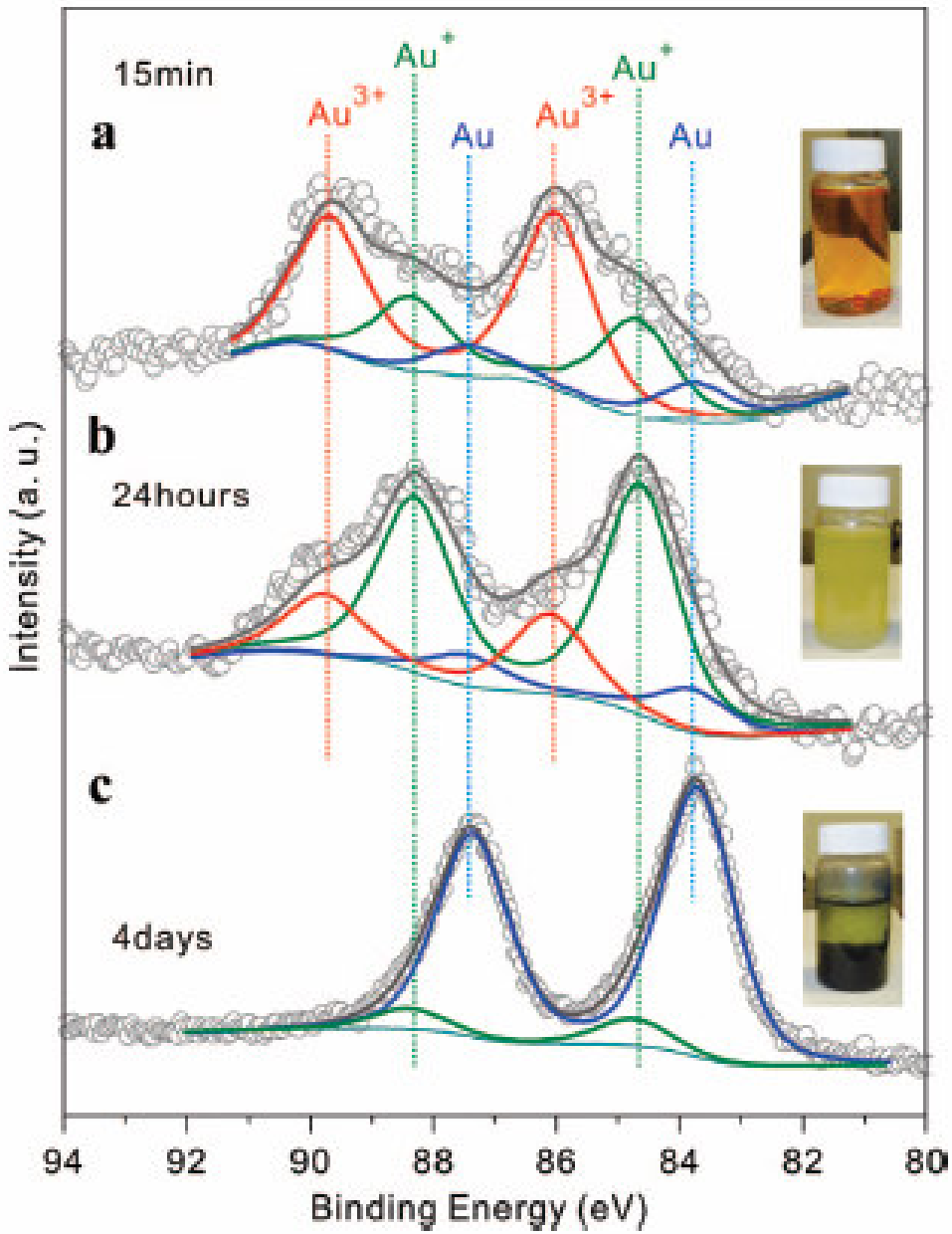
Centrifugation (3500 rpm)
&
Washing with Tolune-ethanol mixture (1:3)



Ultrathin Au nanowires



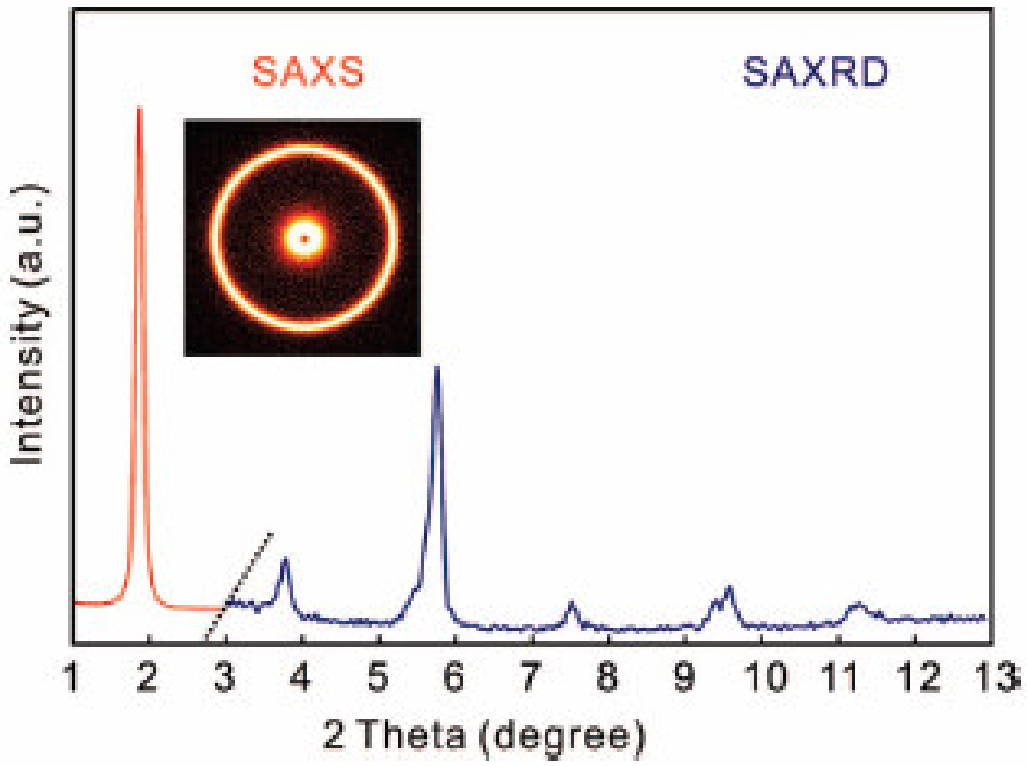
(a-d) TEM images of the ultrathin Au nanowires; (e) HRTEM image of an individual Au nanowire showing the (111) lattice planes.



XPS spectra for Au species at different reaction times. Insets show the corresponding digital camera images of the resulting solutions, respectively.

Table 1. Evolution of the Au Species at Different Stages of the Reaction

	relative ratio of XPS Au 4f peak		
reaction time (h)	Au^{3+}	Au^{1+}	Au^{0}
0.25	55.7	31.4	12.9
24	22.9	65.0	12.1
96	0	9.1	90.9



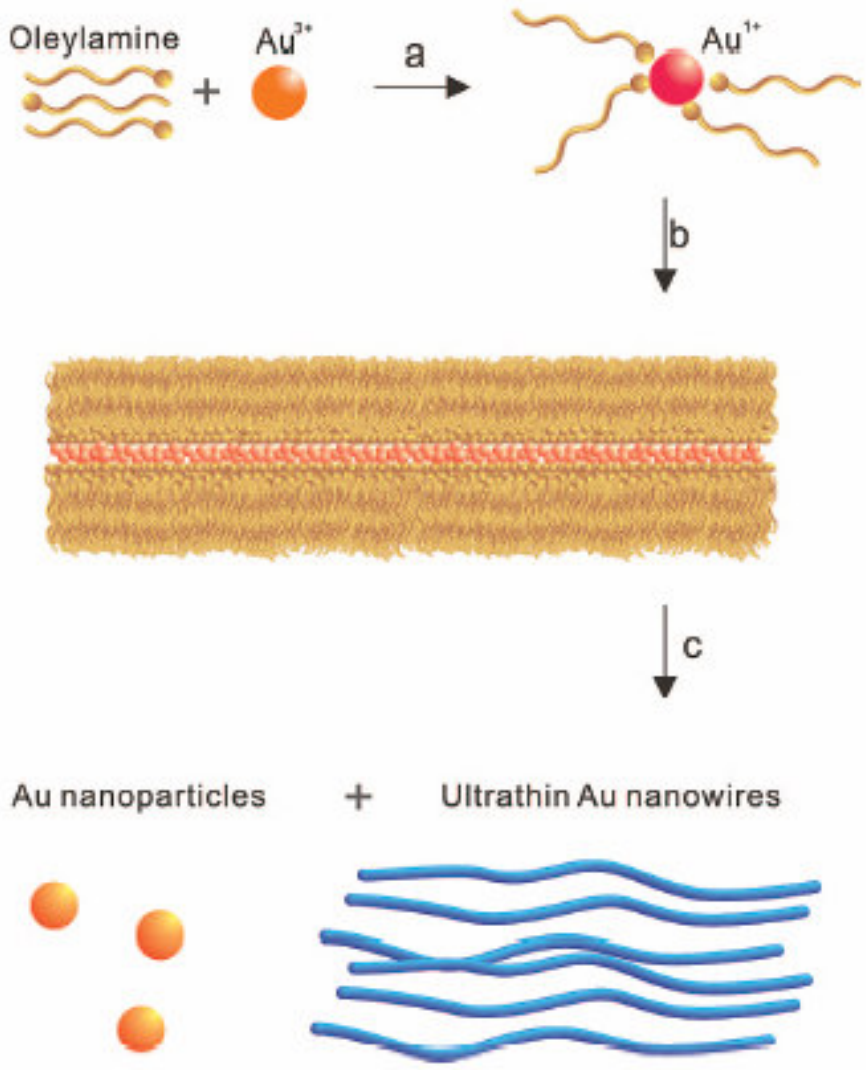
SAXS → *High degree of ordering within this mesostructure.*

SAXRD → *Six diffraction peaks with d-spacings of 4.720, 2.336, 1.533, 1.176, 0.922, and 0.784 nm were indexed as (00l) series for a mesostructure where Au^{+} assemblies were separated by 4.7 nm, roughly the width of an oleylamine bilayer.*

Combined SAXRD (blue) and SAXS spectra (red) recorded on the whitish Au^{+}-oleylamine gel. The inset shows the corresponding SAXS pattern.

Mechanism of Nanowire formation

A cooperative assembly between the inorganic metal salt and the oleylamine synchronized with a stepwise reduction of gold precursor within the mixture.



Important features:

(1). The formation of ordered mesostructure between the ionic inorganic precursor and the oleylamine.

(2). The slow in situ reduction of metal ions within the mesostructure.

Conclusion

- Ultrathin (1.5-1.8 nm) and high aspect ratio (up to 4 μm) gold nanowires were successfully synthesized by simply mixing a gold precursor with oleylamine.

- The cooperative interaction between the gold precursor and the oleylamine leads to a mesostructure formation followed by slow in situ reduction.

- The mesostructures of the Au^{+}-oleylamine complex serve as growth template and govern the anisotropic growth in nanoscale.