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PROCEEDINGS

Quasi-Two-Dimensional Gold Nanosheets with Ultrahigh Strength

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ABSTRACT

Solid gold usually holds face-centered-cubic structure and relatively low strength of 10^2 MPa. When the dimension is reduced to the nanoscale, the strength of metal should increase accordingly, due to size effect or complex nanostructures [1-3]. However, reported maximum strength in gold nanostructures is yet considerably lower than the ideal strength (~6 GPa), referring to the stress at elastic instability in a defect-free crystal with infinite dimensions [3-5]. Herein, the ideal strength of gold is experimentally achieved in a quasi-two-dimensional defect-free single crystalline nanosheet with hexagonal-close-packed (HCP) structure. Ultrathin gold nanosheets with a high aspect ratio (lateral size $>10^1$ μm, thickness <10 nm) were synthesized using a wet-chemical method [6]. The HCP structure of the ultrathin nanosheets was confirmed by high resolution transmission electron microscopy. Nanoindentation measurements were performed on suspended gold nanosheets with various thicknesses using an atomic force microscope. The mechanical behavior exhibits strong thickness dependence, reaching a remarkable maximum strength of 6.0 GPa, when the thickness is less than 10 nm. First-principle calculations based on density functional theory were carried out to support the experiments. We attribute the ultrahigh strength to the unique defect-free HCP structure and strong surface effect.

KEYWORDS

Ultrathin gold nanosheets; defect free; hexagonal-close-packing; ideal strength

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