Thermal Stabilization of Localized Plasmon Sensors

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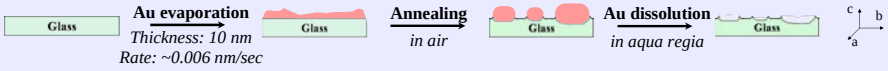
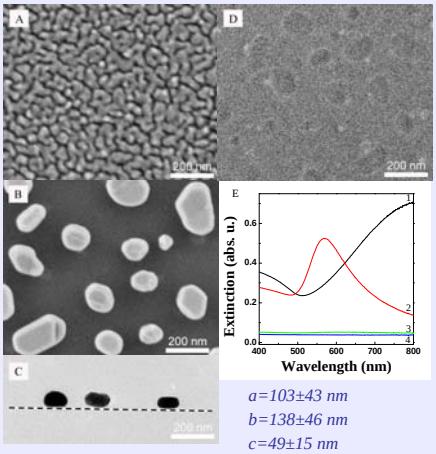
A simple and general preparation procedure is presented, providing strongly bonded and morphologically stable gold island films on glass substrates without any intermediate adhesion layer or protecting overlayer.

The new approach is based on high-temperature annealing of Au island films evaporated on glass. The annealing is carried out in air at temperatures close to the glass transition of the glass substrate, leading to partial embedding of the metal islands in the glass. The morphology and optical response of the embedded Au island films are exceedingly stable toward immersion in solvents (including PBS), drying, and self-assembly of biological molecule. The simplicity of the preparation and the high refractive index sensitivity point to applications of stabilized Au island films as transducers for localized surface plasmon sensors.



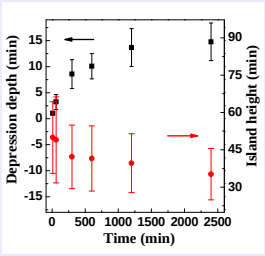
Morphology: HRSEM and cross-sectional TEM



a=103±43 nm
b=138±46 nm
c=49±15 nm

A - *as prepared;* B, *C – annealed 10 hours at 550 °C;*
D – *after Au dissolution in aqua regia;*
E – *UV/vis spectra: 1 – as prepared, 2 - annealed, 3 - after Au dissolution in aqua regia, 4 – bare glass.*

Kinetics of island embedding at 600 °C



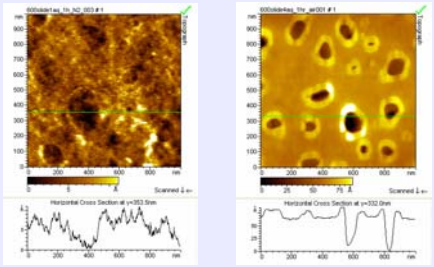
Island height + depression depth ≈ 50 nm

Indicates embedding with minimal reshaping.

Influence of the annealing environment: AFM

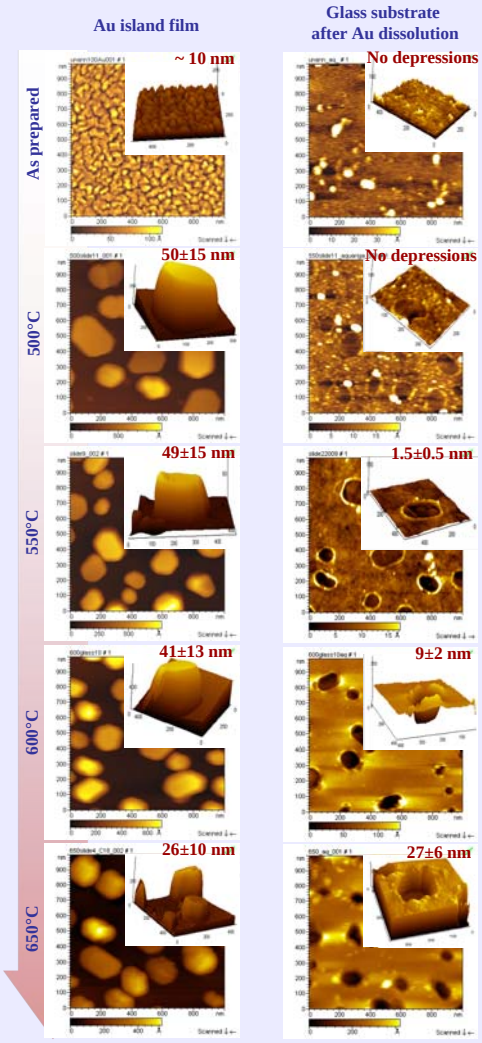
The Au film was annealed 1hour at 600 °C in air and in nitrogen atmosphere, followed by Au dissolution.

N_2 air



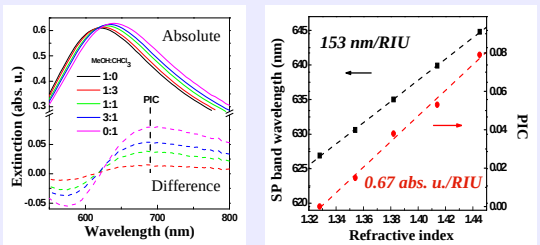
Conclusion: Embedding requires the presence of O_2.

The effect of annealing temperature: AFM

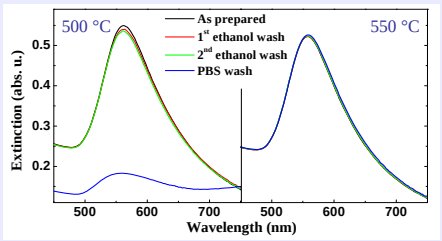


Refractive index sensitivity

Transmission spectra were measured in mixtures of methanol (n=1.33) and chloroform (n=1.45).

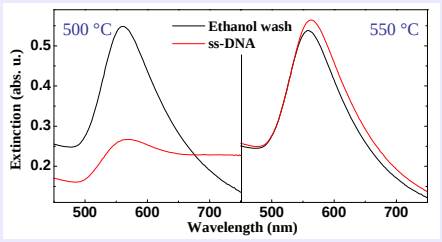


Stability: Solvent immersion and drying



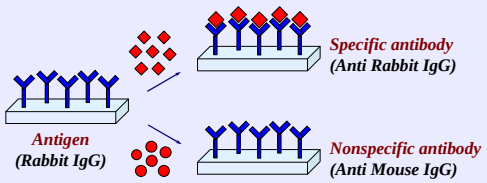
Transmission UV/vis spectra were measured after washing in the solvent and drying under N_2.

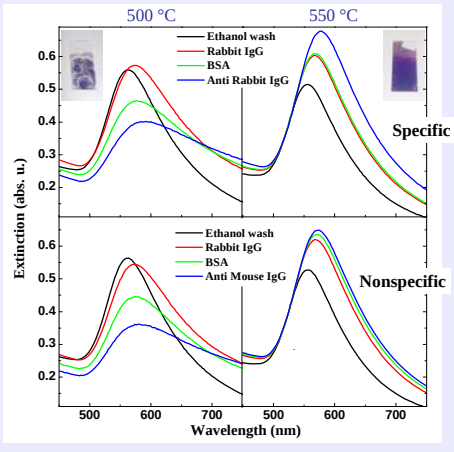
Self-assembly (SA) of ss-DNA



SA of a disulfide-modified 43-base ss-DNA from a 1μM solution in PBS, overnight.

Specific protein recognition





The Rabbit IgG protein was adsorbed from 100 μg ml^{-1} solution in acetate buffer, pH=4.6. The Anti Rabbit / Anti Mouse IgG proteins – from 1 μM solutions in PBS.