

Imaging ellipsometry and BRDF experiments of gold nanoparticles embedded in a polymer matrix

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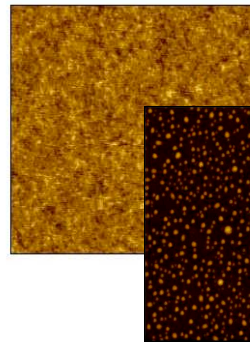
Introduction and research context

Research context and motivation :

- Gold NPs embedded in PVA used as **SATURABLE ABSORBERS** in passive Q-switch systems : importance of roughness
- **Optical properties** of metal nanoparticles (NPs) determined by a collective oscillation of the conduction electrons : **localized surface plasmon resonance (LSPR)**.
- **Model system** : Au⁰ NPs in a poly(vinyl alcohol) (PVA) matrix and chemical reduction of the metal salt by **thermal annealing** of the film ($\lambda_{spr} = 540\text{nm}$)
- **In situ route for synthesis** : spontaneous encapsulation in a matrix during synthesis but less control on the shape/size of the NPs

Optical characterization :

- Study by **imaging ellipsometry** : LOCAL optical properties at the (sub)micron scale using EP3 Accurion Imaging ellipsometer ($\lambda = 658\text{nm}$)



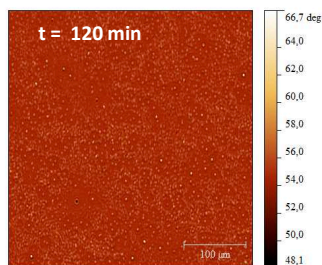
GOLD / PVA nanocomposite

Reduction Au³⁺ / Au⁰ by thermal annealing (135°C, 90min)

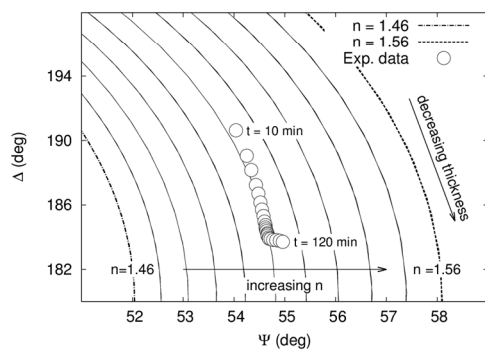
Image size : 10 μm
 AFM, topography

Experimental results

Monitoring of the gold NPs growth via optical diffraction in the IE images



Au-PVA film after 120 min annealing at 140°C : gold NPs induce optical diffraction – Onset of depletion zones



Constant angle of incidence curves at 658 nm and 42° incidence parametrised by film thickness.

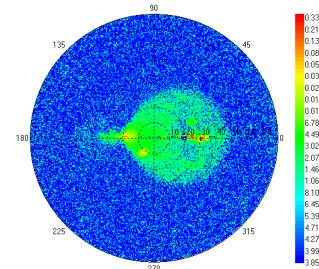
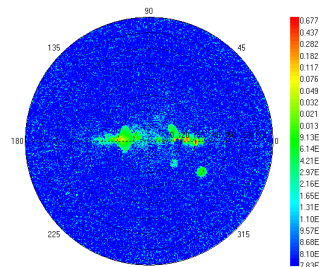
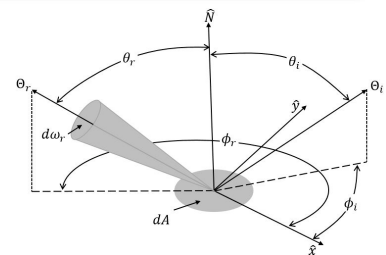
Left most curve : n = 1.46

Right most curve : n = 1.56

Open circles : Gold-PVA optical response

Bidirectional reflectance distribution function

The BRDF of a surface is the ratio of reflected radiance to incident irradiance at a particular wavelength for all scattering angles



BRDF - Scattered intensity at $\lambda = 570 \text{ nm}$

Top : BEFORE annealing, Bottom : AFTER annealing (90 min, 135°C)

Illumination from right to left

- Scattering **strongly** induced by NPs growth
- Important **backscattering** component
- Measurement system : **EZ Contrast, ELDIM, France**

Conclusions and acknowledgements

- IE appropriate even off-resonance
- Light (back)scattered by the annealed sample due to the growth of the gold nanoparticles
- Variation of the thickness and the refractive index during the growth of the NPs

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