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# Growth of gold nanoparticles in a polymer matrix : reflectivity and scattering analysis

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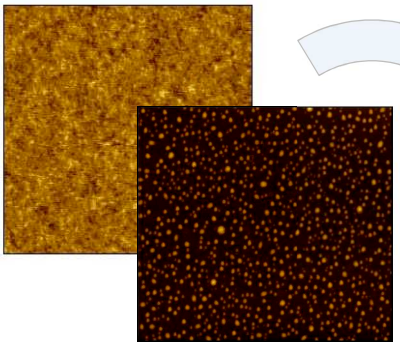
## Introduction and research context

**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 : $Au^0$ NPs in a poly(vinyl alcohol) (PVA) matrix and chemical reduction of the metal salt by thermal annealing of the film ($\lambda_{spr}$ = 530nm)
- *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 home-build spectroscopic reflectometer with CSS200 Thorlabs spectrometer (integration time : 12ms) and temperature control.



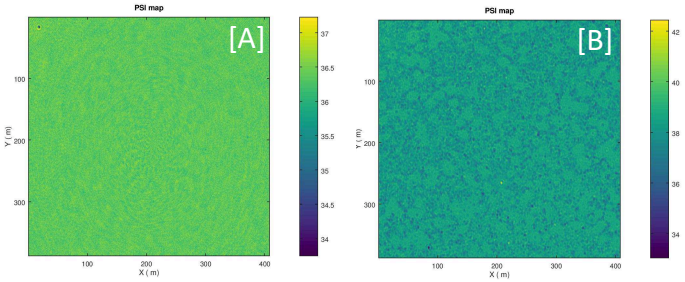
GOLD / PVA nanocomposite

Reduction $Au^{3+}$ /$Au^0$ by thermal annealing (135°C, 90min)

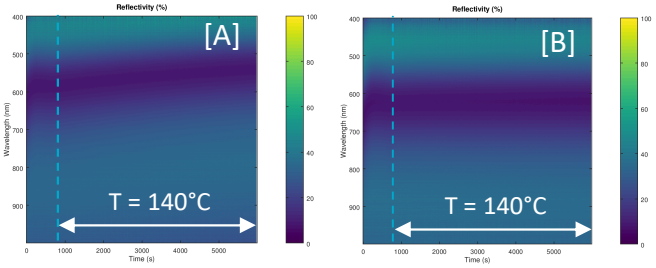
*Image size : 10 µm*
*AFM, topography*

## Experimental results

### Monitoring of the gold NPs growth : LOCAL versus GLOBAL changes of optical properties




Imaging ellipsometry (IE) maps of Au-PVA film [A] before annealing and [B] after 60 min annealing at 140°C : gold NPs induce optical diffraction – Onset of depletion zones

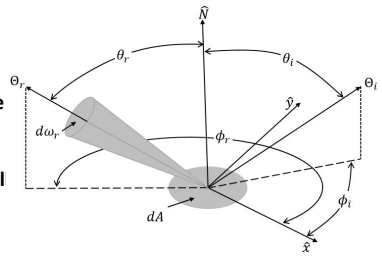


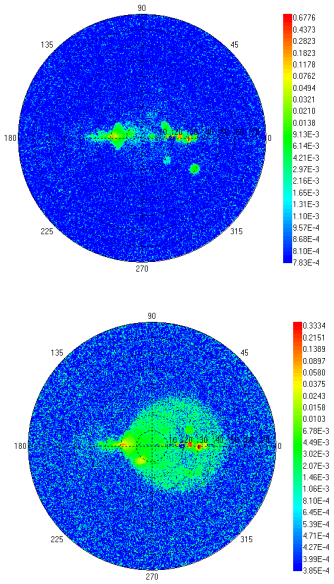

Spectroscopic reflectivity (SR) of [A] Au-PVA film and [B] PVA film during the annealing (changes in the first 720s due to the glass transition : dashed line)

**No clear changes with time on the SR map and visible changes on the IE map**

### Bidirectional reflectance distribution function

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




BRDF - Scattered intensity at $\lambda = 570\ nm$

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

- At low Au-doping levels, IE is much more sensitive than conventional SR because it provides a LOCAL information on optical properties
- Light (back)scattered by the annealed sample due to the growth of the gold nanoparticles

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