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William d'Orsonnens, Florian Lamaze, Abdelhamid Hmima, Julien Proust,
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Plasmonic pressure sensor based on PDMS thin films

William d'Orsonnens¹, Florian Lamaze¹, Abdelhamid Hmima¹, Julien Proust¹, Éric Finot², Thomas Maurer¹

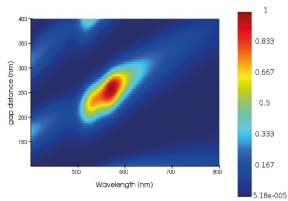
¹ Light, nanomaterials, nanotechnologies - CNRS ERL 7004 - Troyes, France

² Interdisciplinary Laboratory Carnot of Burgundy, CNRS UMR 6303 - Dijon, France

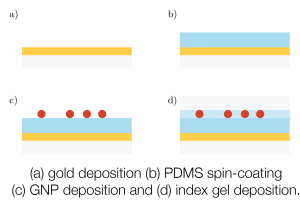
PDMS (Polydimethylsiloxane) has been widely used in a lot of biological applications due to its great biocompatibility. However, its **optical and mechanical properties** also make it a perfect medium for **plasmonic-based mechanical sensors**. We attempted here to present a first design of this kind of sensor leading to either a **pressure or a stress sensor**.

Pressure sensor: design and simulation

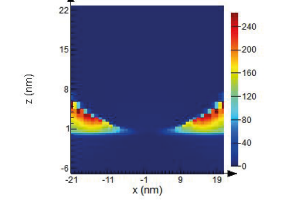
PDMS thickness VS Reflexion



Sensor's design



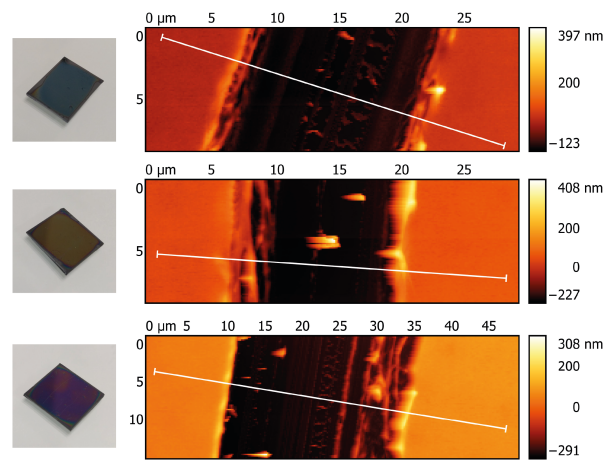
Enhancement Factor



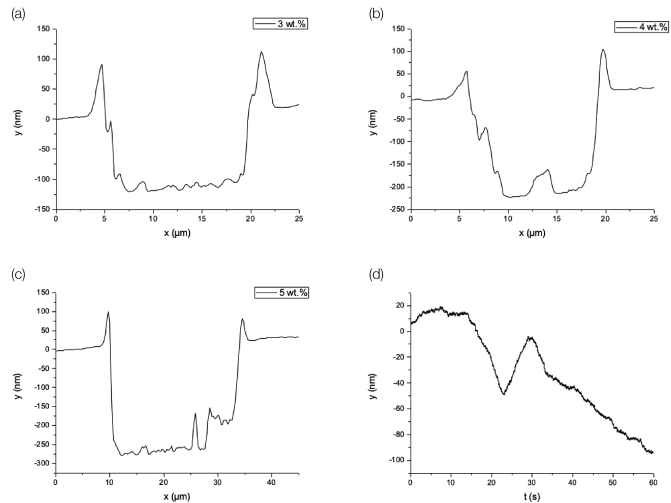
➔ Great potential of exaltation: could be used with plasmon-enhanced Raman spectroscopy by adding a molecular probe.

PDMS spin coating with Tert-Butyl alcohol: towards a consistent deposition

AFM measurements



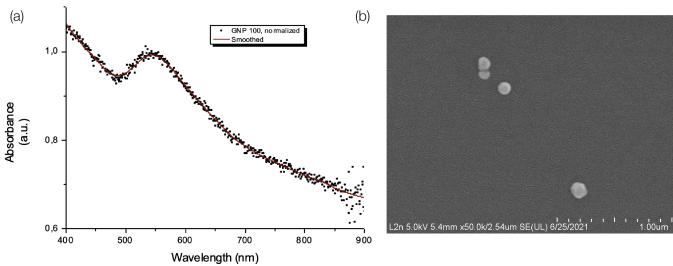
(a) 3 wt.% PDMS:TBA, thickness value approx. 120nm (b) 4 wt.% PDMS:TBA, thickness value approx. 230nm and (c) 5 wt.% PDMS:TBA, thickness value approx. 300nm.



(a), (b) and (c) height profile from the AFM images shown above, force setpoint 500pN (d) height profile (profilometer scan in static mode 30µN), showing that PDMS has been deposited (tip is pushing down in static mode which corresponds to the elastomeric properties of PDMS).

➔ PDMS has been spin-coated with great reproducibility on different substrates (silicon, glass, gold...) at different thicknesses. It could be tuned by changing its concentration.

PDMS film fonctionnalization and GNP deposition



(a) Absorbance spectra of (b) colloidal gold nanoparticles (GNP) deposited on a 3-Aminopropyltriethoxysilane (APTES) functionalized PDMS layer on glass (c) Fonctionnalisation has been done in vapor phase adding pure APTES in an argon-filled petri dish at 170°C.

➔ Gold nanoparticles can be grafted on the PDMS film as a plasmonic sensor. They can be tuned for their SPR peak to fit the laser's wavelength.

Conclusion: towards a multi-scale stress sensor by adding micrometric structures



By transferring big structures on PDMS, we imagined a multi-scale sensor which could track the displacement of micrometric patterns. They would also act as a reflective coating or even a coupling media in order to enhance SERS signal. A thin PDMS layer would be spin-coated on top to act as a cavity. Finally GNP and a molecular probe (e.g. methylene blue) would be deposited.

➔ New type of sensor at the interface of mechanics and plasmonics which could overcome the well-known resistive sensors.

References

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