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Tunable sensitivity of a biosensor by strain modulation of a gap between gold dimers

Florian Lamaze¹, William d'Orsonnens¹, Abdelhamid Hmima¹, Julien Proust¹, Louis Giraudeau²
Éric Finot³ and Thomas Maurer¹

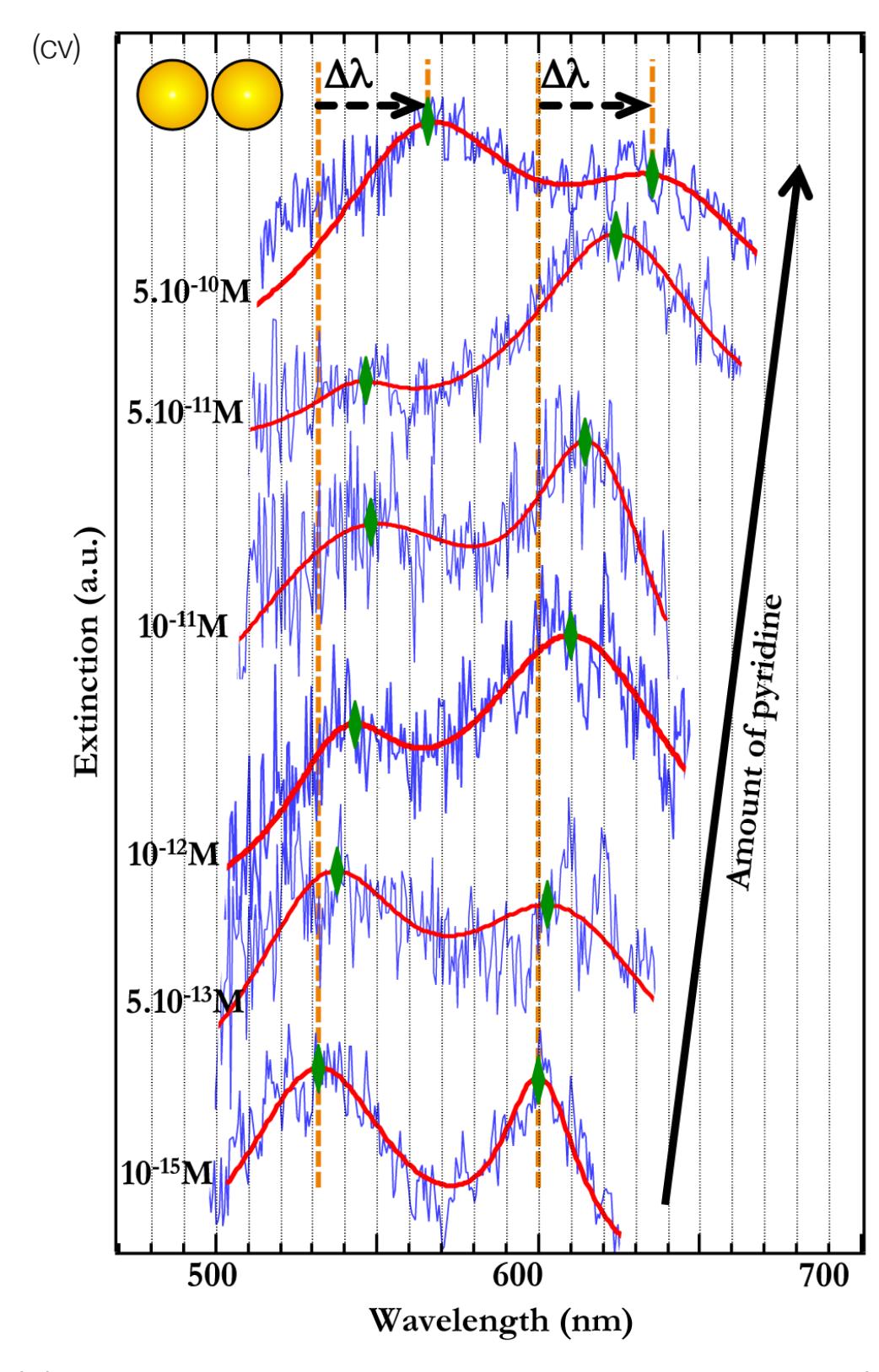
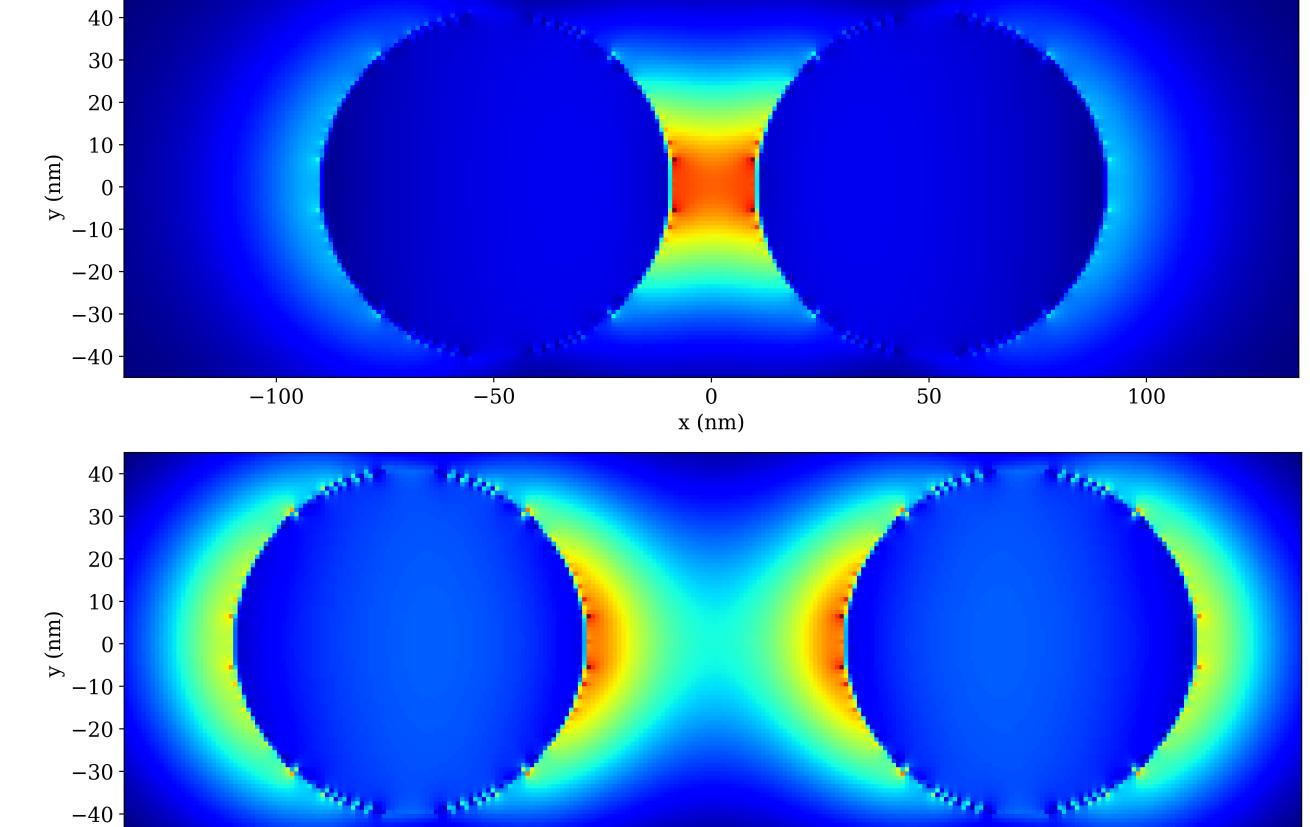
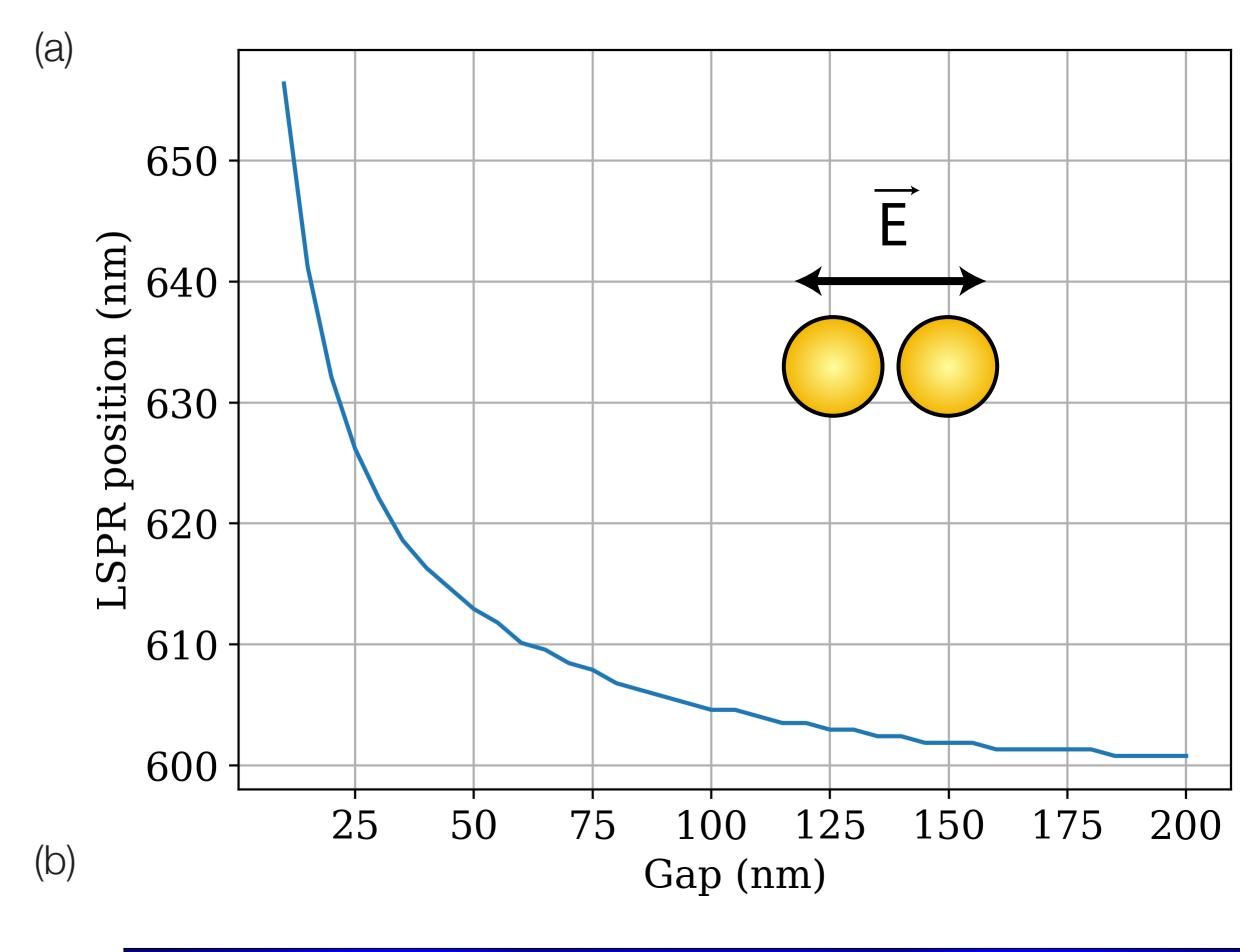
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PDMS (Polydimethylsiloxane) **optical and mechanical properties** make it a perfect medium for **plasmonic-based biosensors**. The project presented here takes advantage of the **elastic properties** of PDMS, and of **gold dimers transferred onto it** to increase the detection threshold of **MUA (Mercaptoundecanoic acid)**.

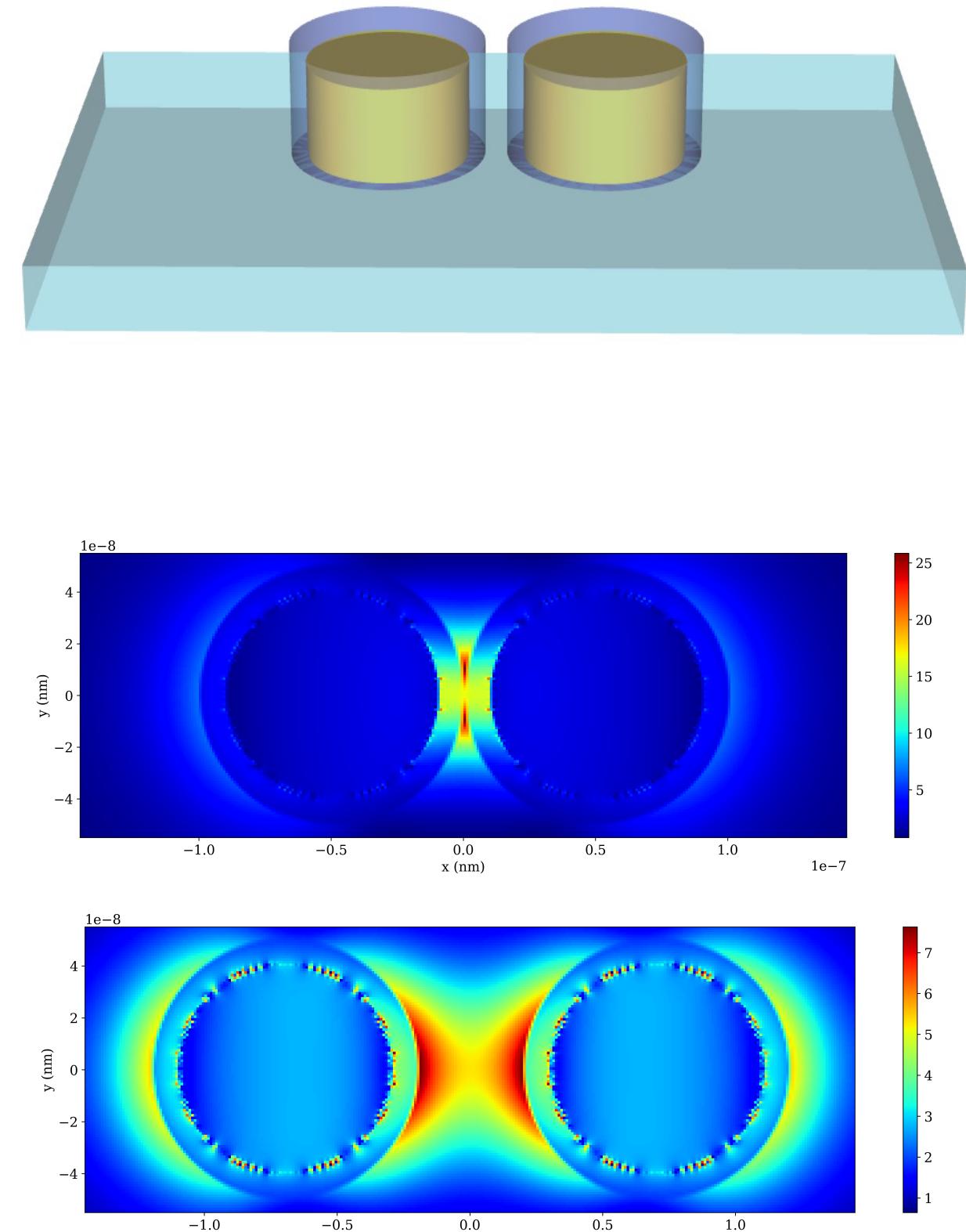
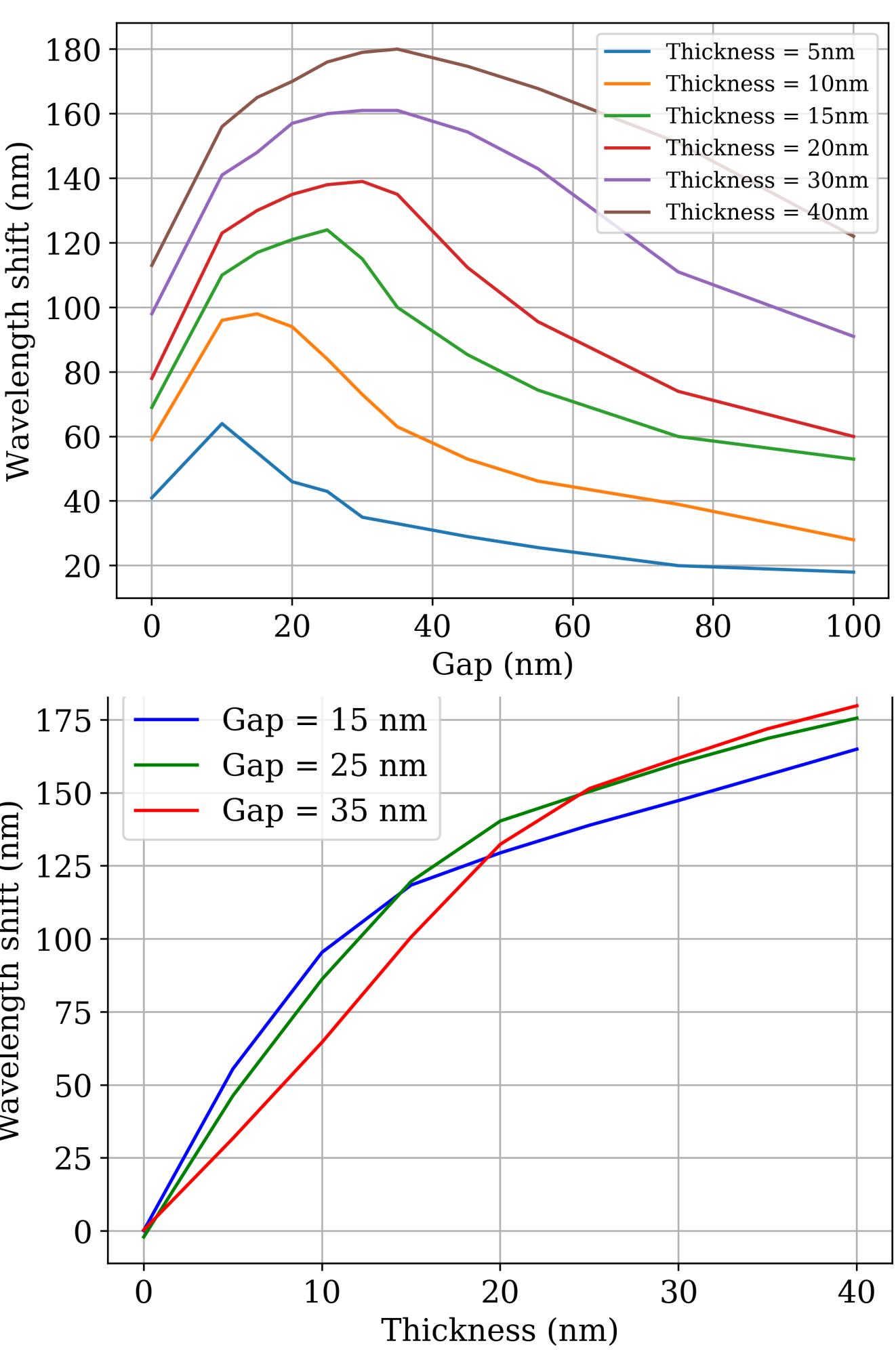
Adaptive sensor: design and simulation



(a) Impact of the gap size on peak position, (b) FDTD maps of the EM field for gaps 20nm (top) and 60nm (bottom) and (c) experimental sensogram on dimers with pyridine, from [1]

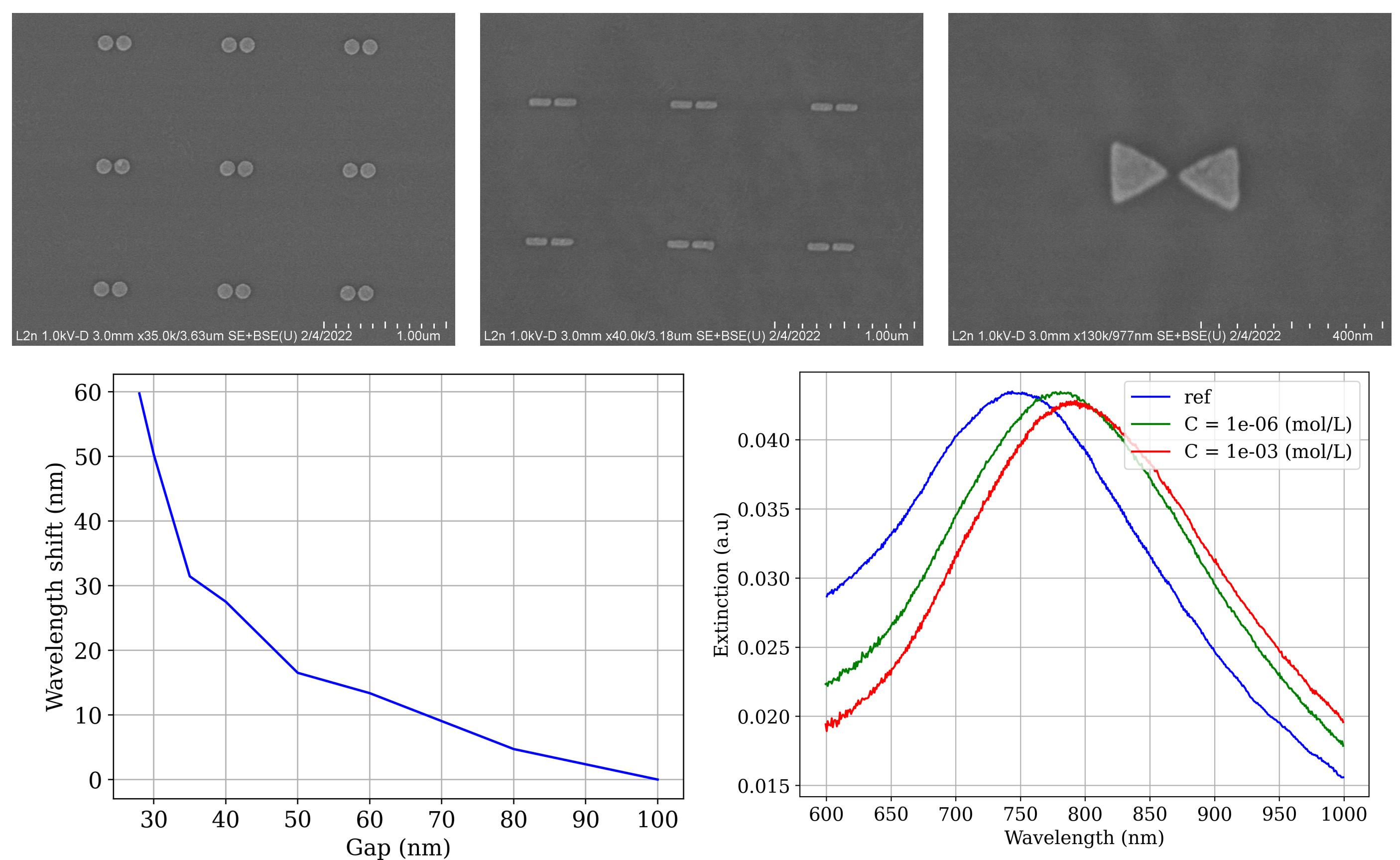
→ EM field is sensitive to the gap mode, which can be used to detect different molecule concentrations.

Simulated addition of MUA on gold dimers



→ Simulation shows that for each concentration of MUA, there is an optimal gap to enable the highest wavelength shift of the plasmonic resonance.

Optical measurements on glass



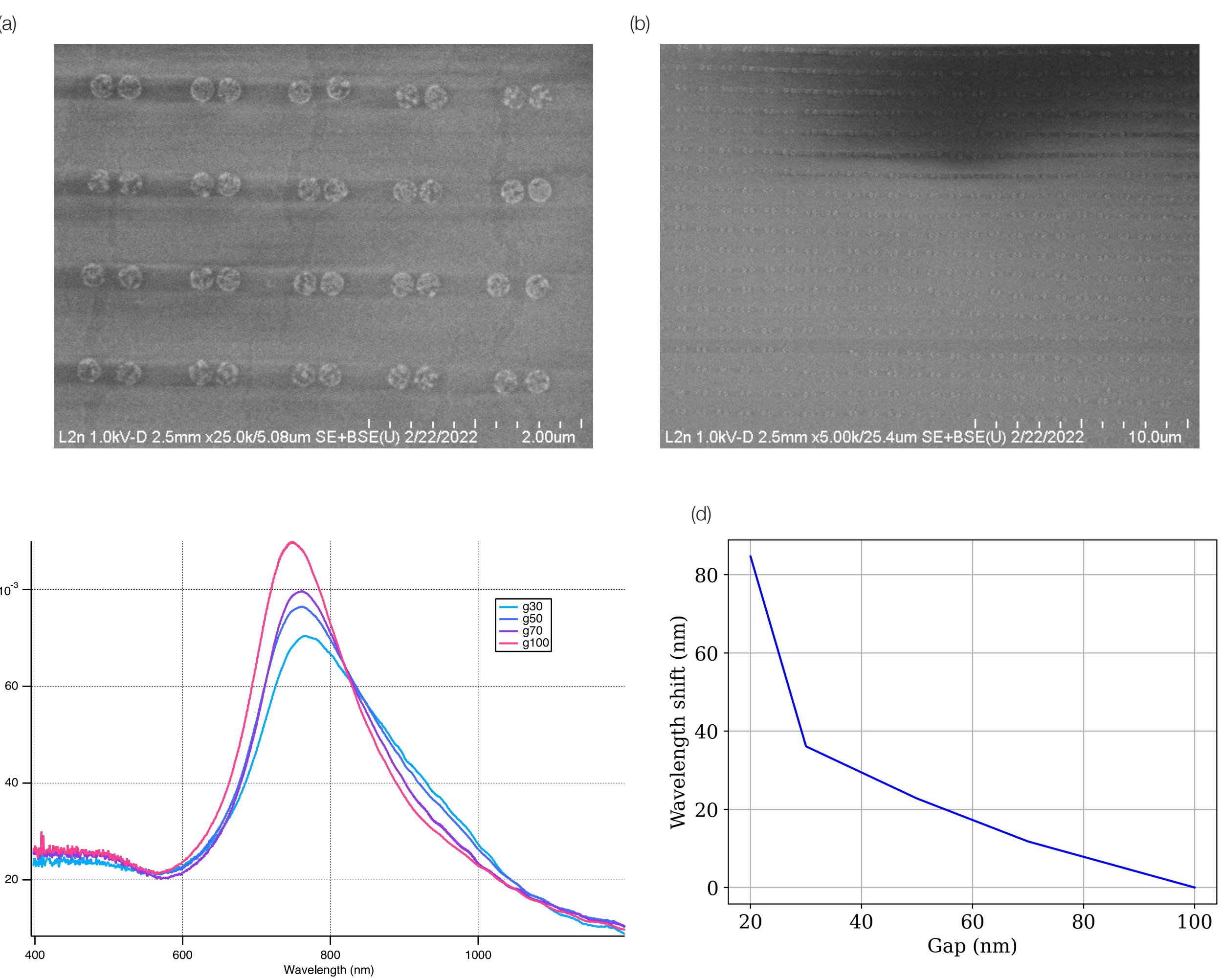
→ Experimental results on glass show a similar behavior than FDTD simulations. New experiments will be done to select the optimal molecule to avoid sensor saturation.

References

[1] Julien Proust. Etude, caractérisation et optimisation expérimentales de nano-capteurs plasmoniques. Micro et nanotechnologies / Microélectronique. Université de Technologie de Troyes, 2014.

[2] Laible, F., Gollmer, D. A., Dickreuter, S., Kern, D. P. & Fleischer, M. Continuous reversible tuning of the gap size and plasmonic coupling of bow tie nanoantennas on flexible substrates. *Nanoscale* 10, 14915–14922 (2018).

Transferring structures on PDMS to make an adaptive sensor



(a) and (b) SEM images of gold dimers transferred on PDMS using a chemical etching of a sacrificial layer [2].
(c) Extinction signal of the particles on PDMS: when the gap size decreases we get the expected redshift.
(d) peak position shift while increasing the gap size.

→ Particles can be transferred on a flexible substrate and show similar behaviour than on glass, thus we can expect to get an adaptive sensor by applying strain on the sample.