

Cell-Detachment from Plasmonically Active PET Substrates by Application of Near-Infrared Light

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European Research Council

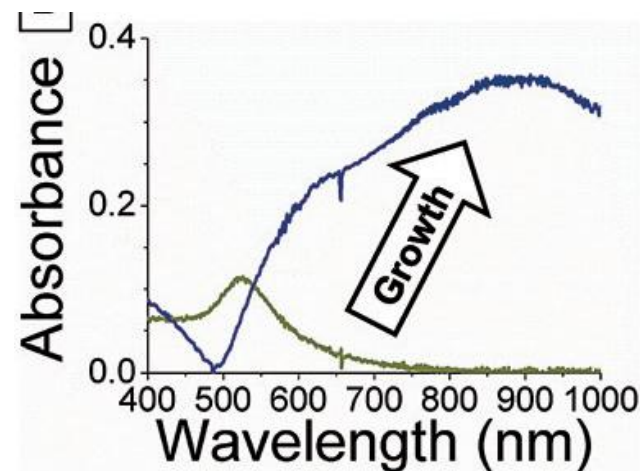
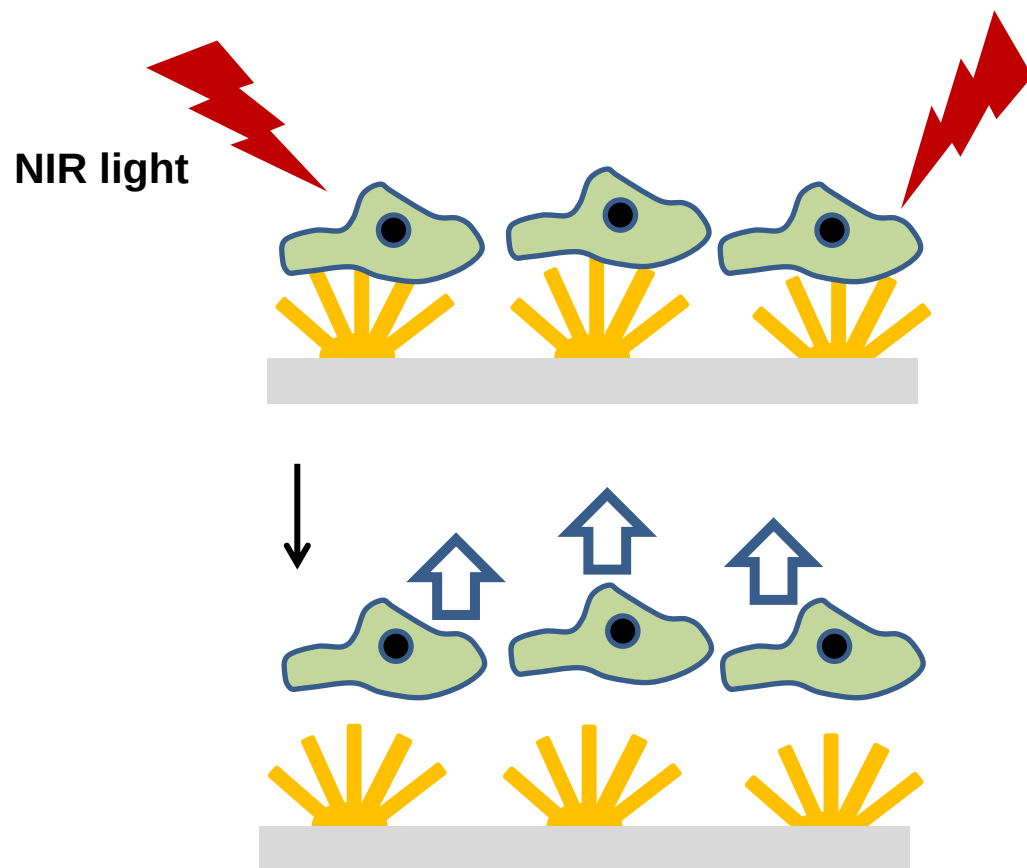


Cell-Detachment Challenge

- Cell culture is an important process with numerous applications.
- Cells must be **detached** from surfaces during harvesting
- Common methods, including **cell scraping** and **trypsin**, can cause cell damage.
- **NIR plasmonic substrates** offers a cheap, efficient and mild alternative.

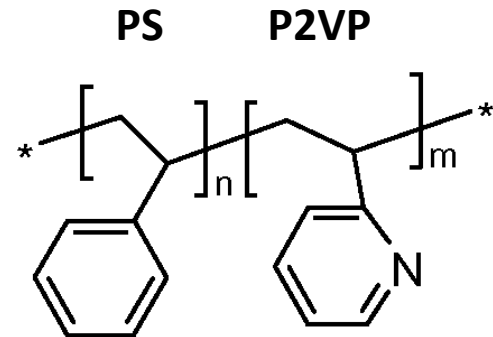
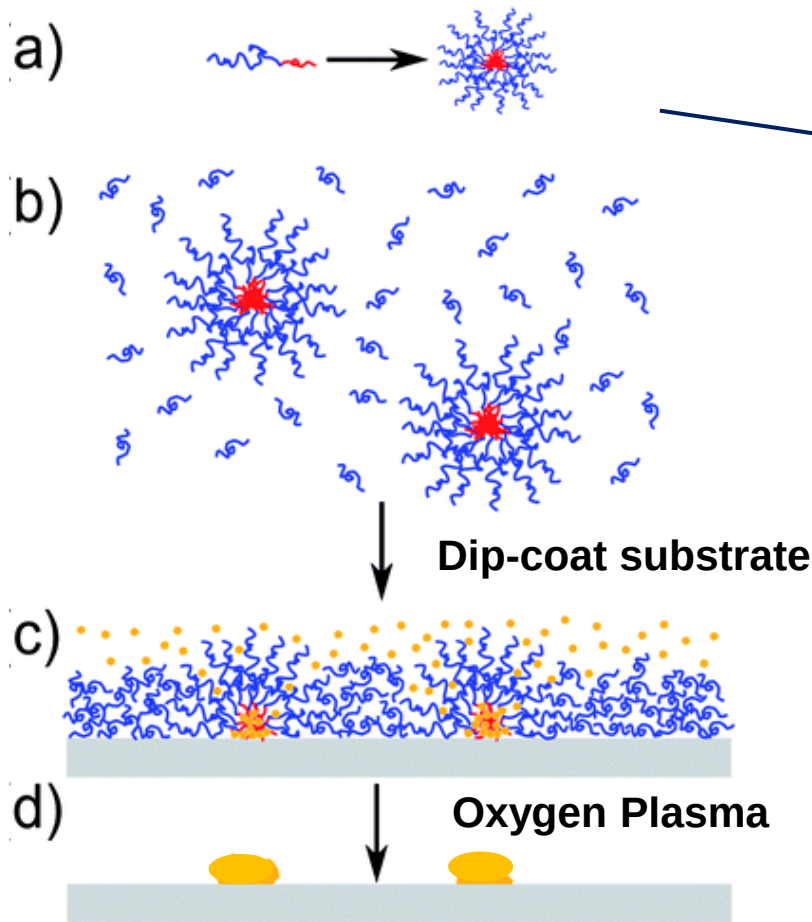


NIR Plasmonic Substrates



Surfaces for Cell Growth and Near-Infrared Light Triggered Retrieval
Angew. Chem. Int. Ed. 2016, 55, 974-978

Block Copolymer Micelle Nanolithography

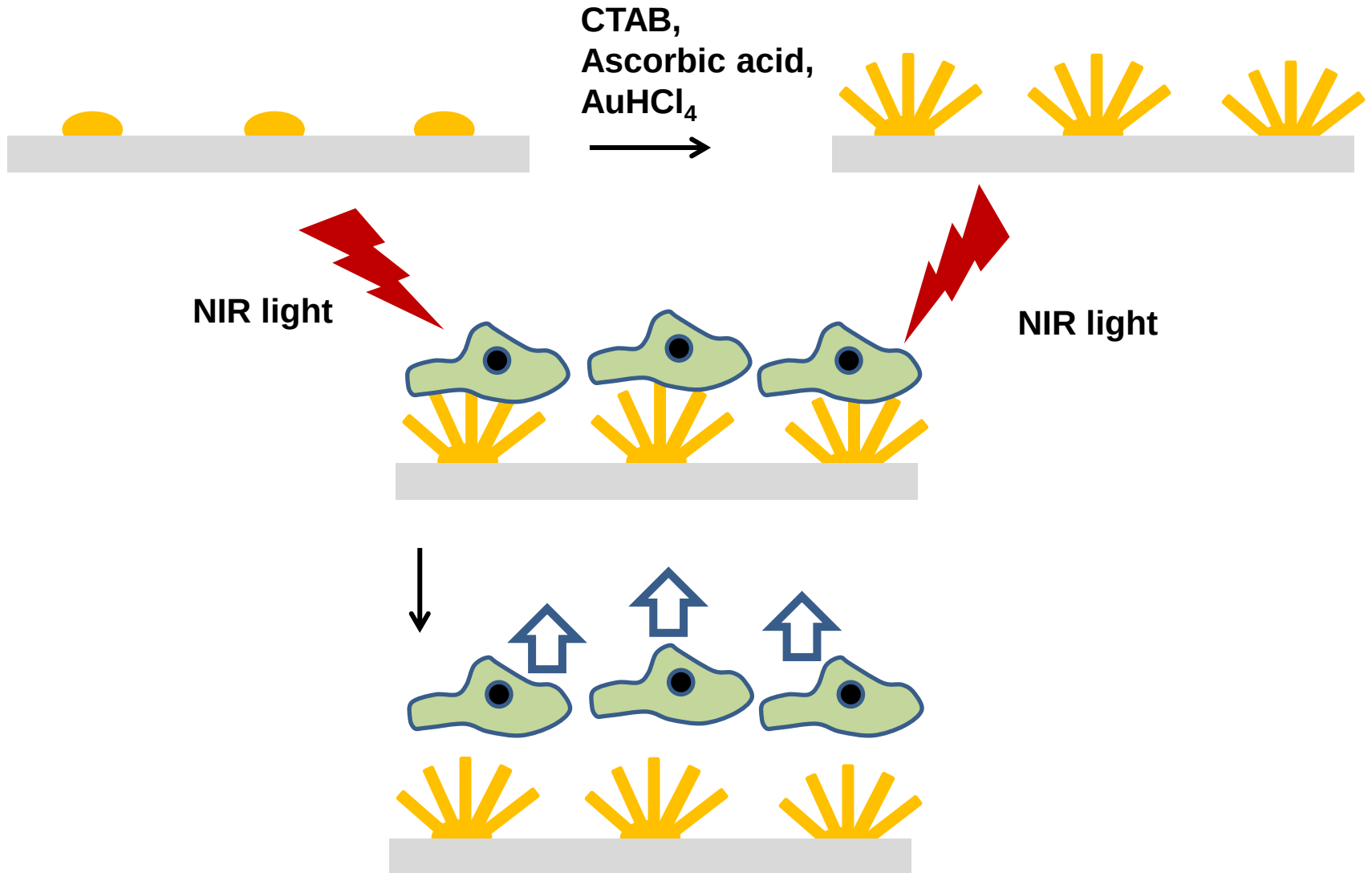


- a) Form inverse micelles in toluene
- b) Load micelles with AuHCl_4
- c) Dip-coat substrate
- d) Expose to oxygen plasma to form nano-seeds

Surfaces for Cell Growth and Near-Infrared Light Triggered Retrieval

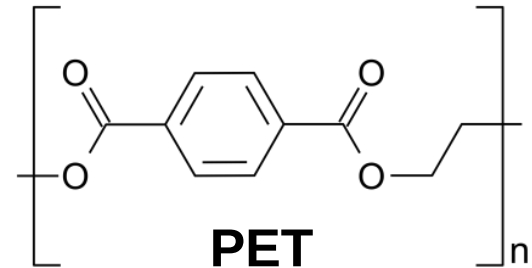
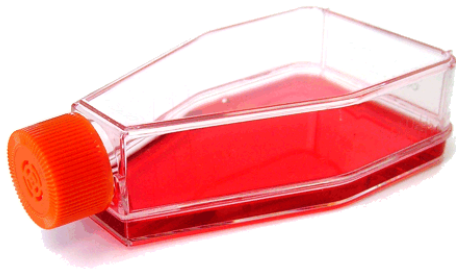
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Anisotropic Growth from Au seeds

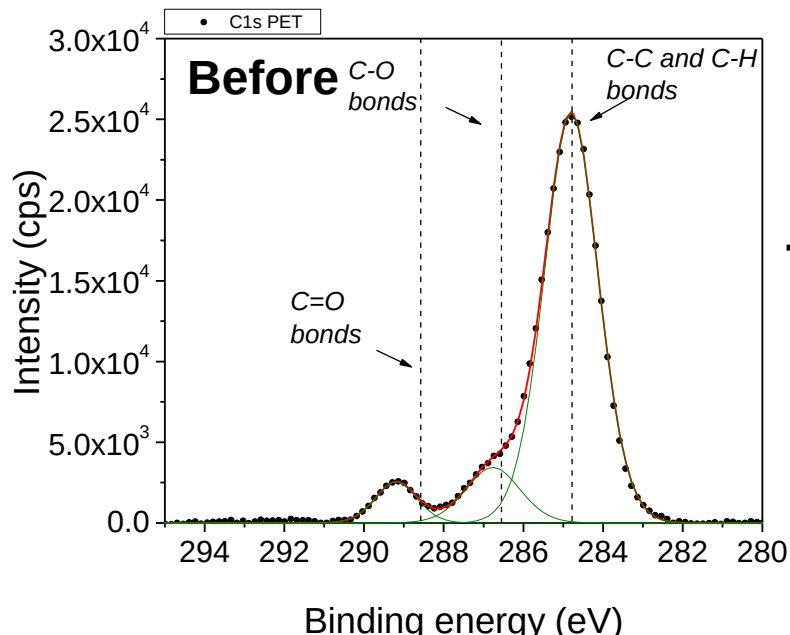
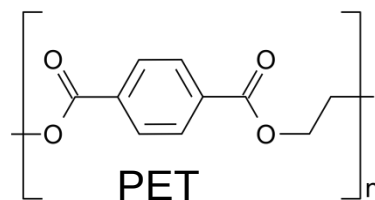


Alternative cell culture substrates?

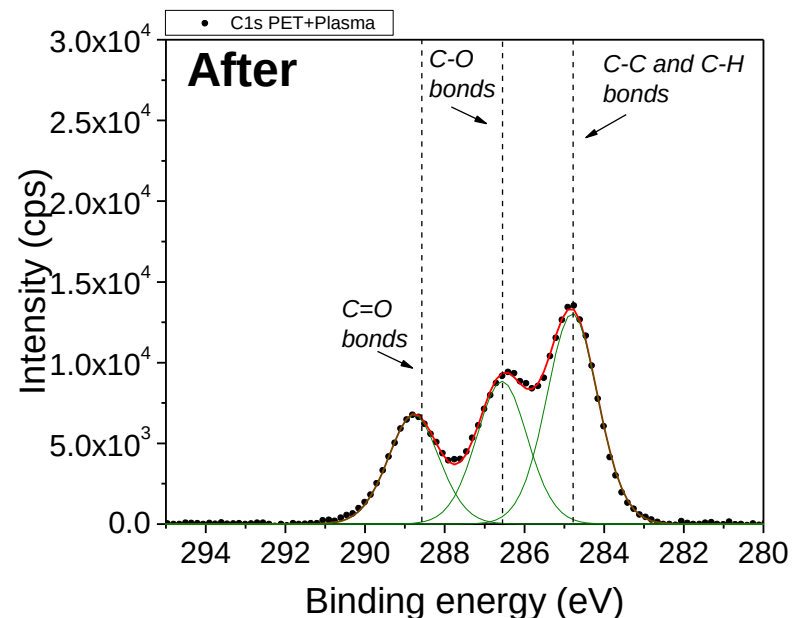
- Can plastic cell culture devices be rendered plasmonically active?
- **PS** and **PET** commonly used due to optical clarity, ease of sterilization and low cost.



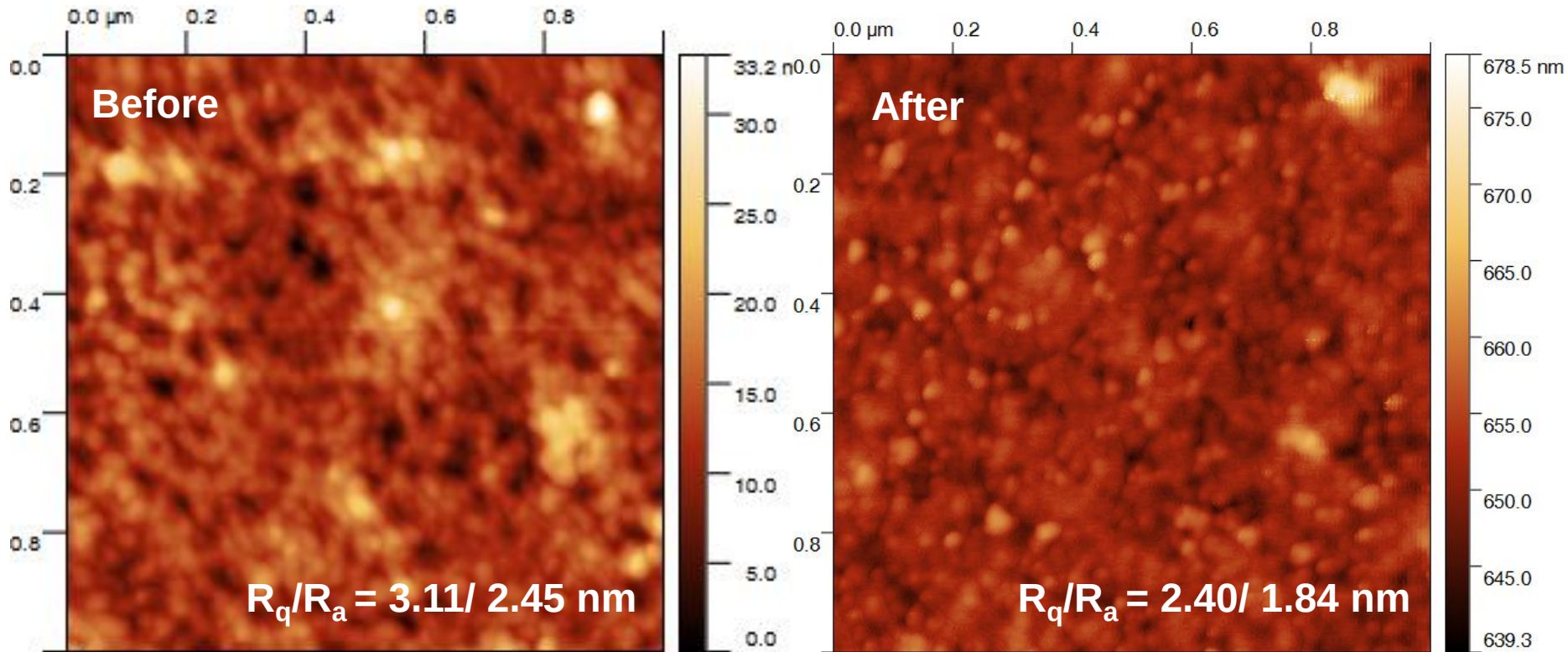
XPS of PET Substrate Before and After Plasma Treatment



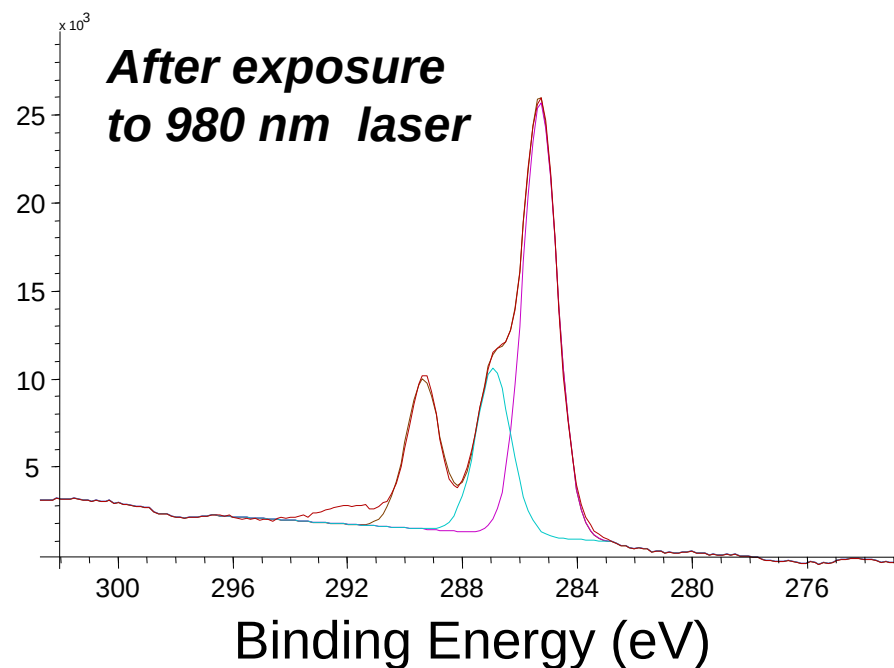
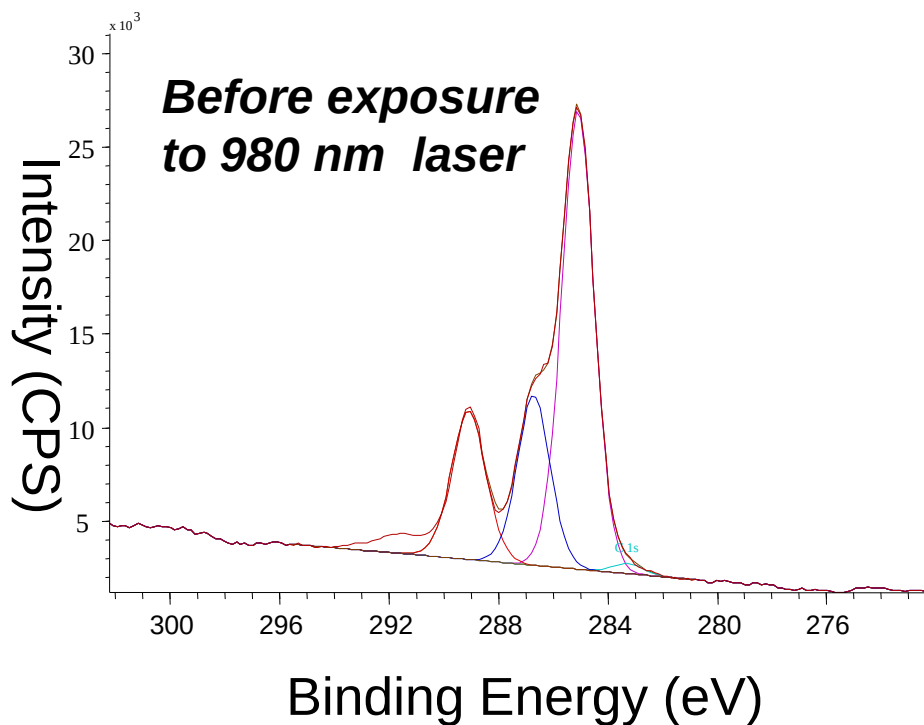
Plasma



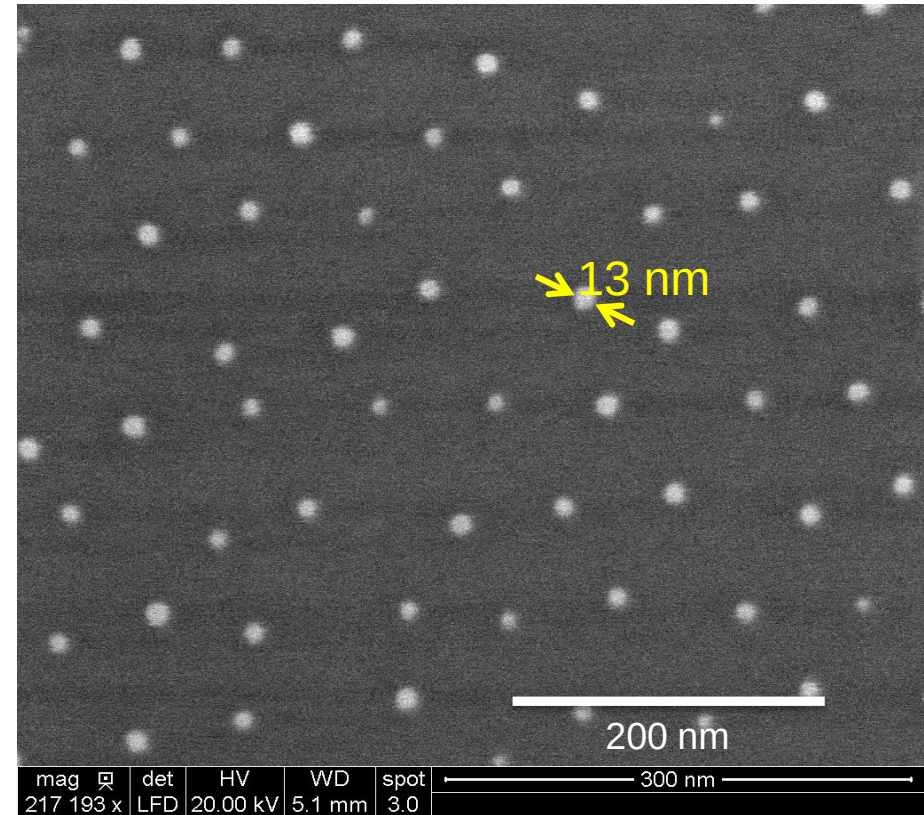
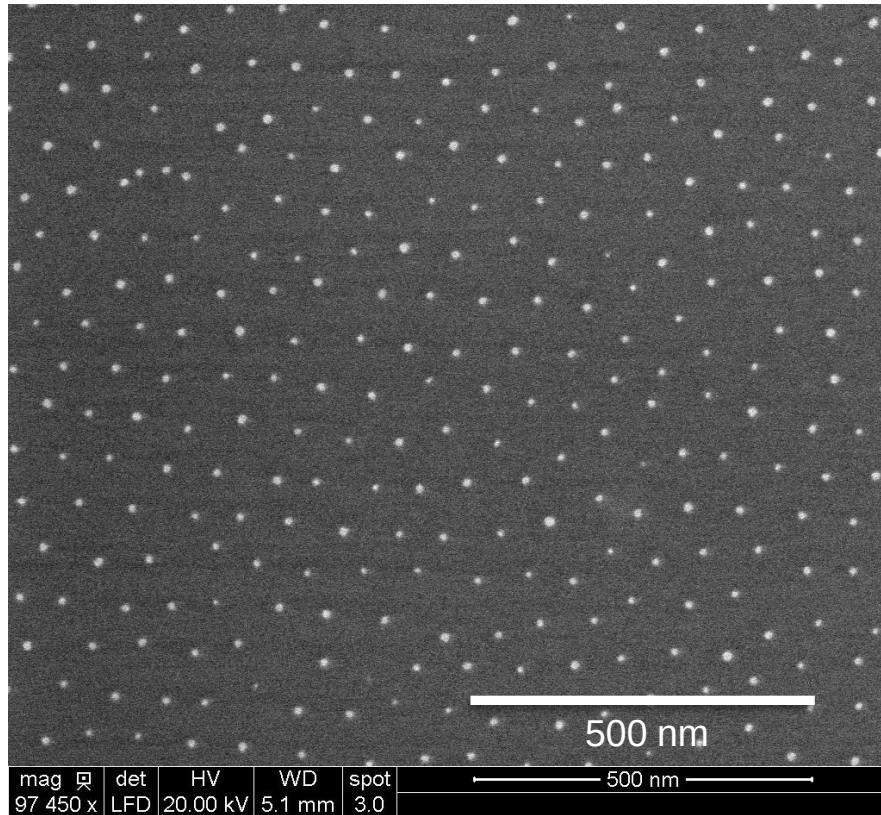
AFM of PET Substrate Before and After Plasma Treatment



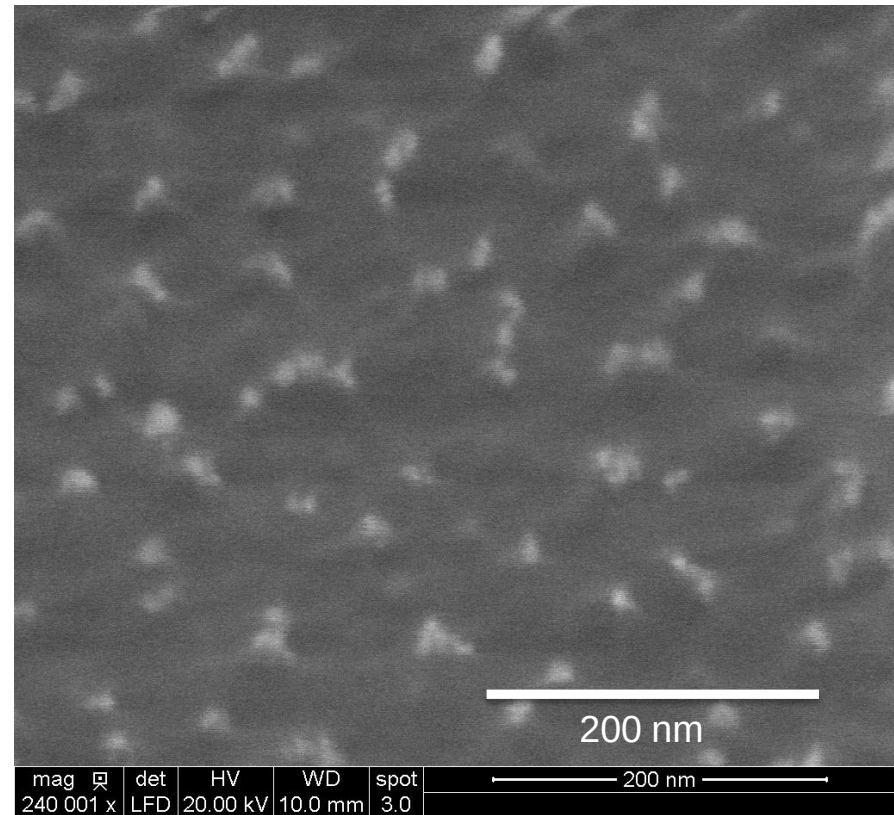
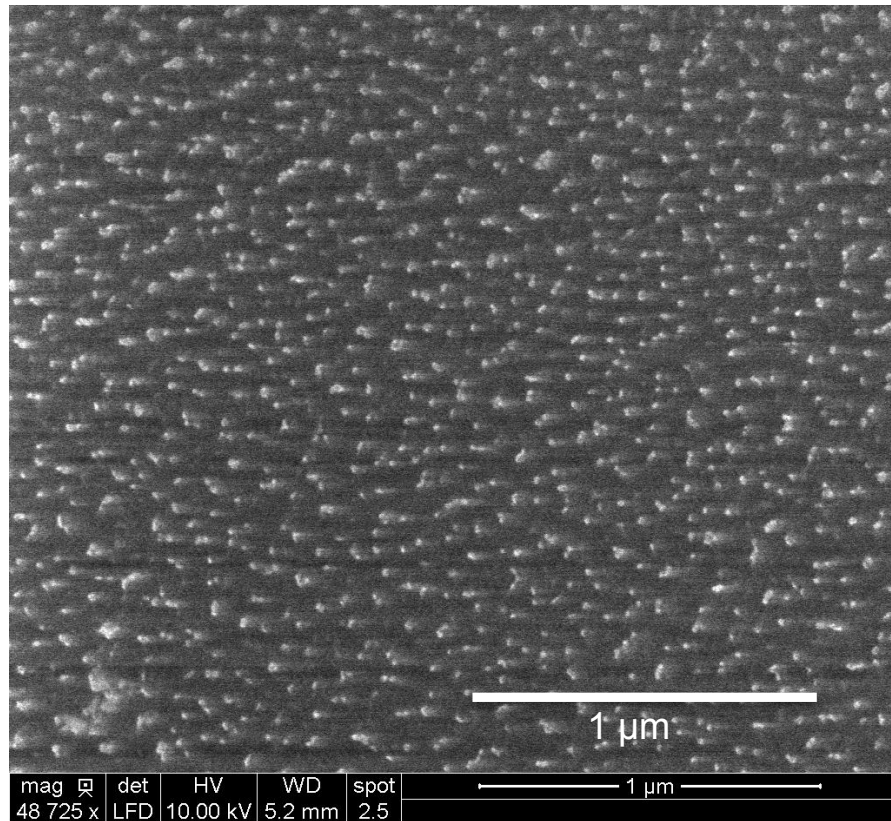
XPS of PET Substrates Before and After Laser Exposure (500 mW cm⁻²)



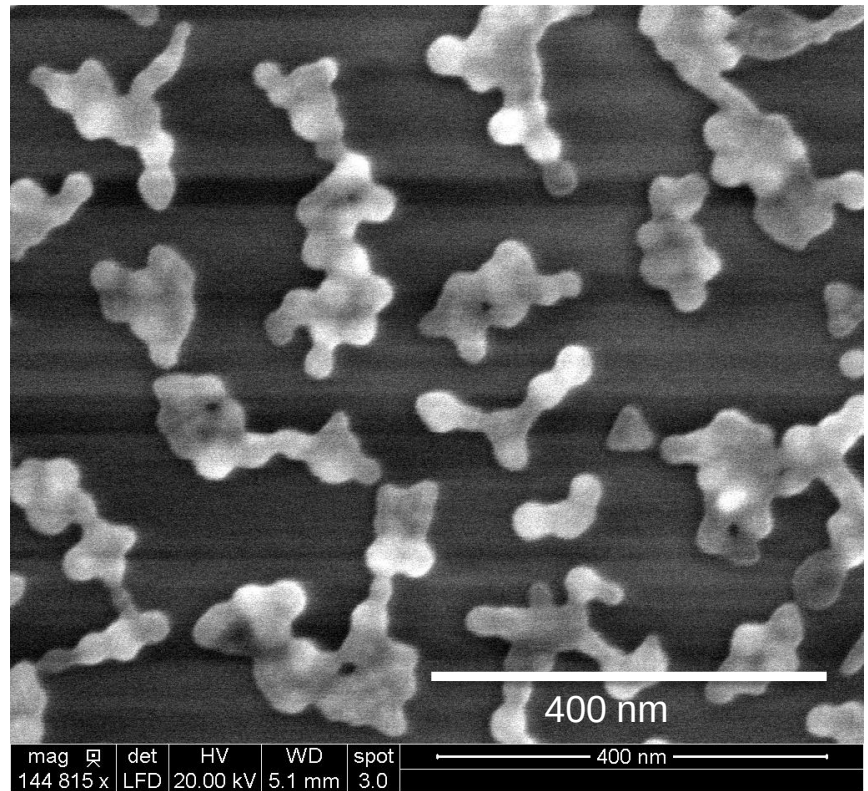
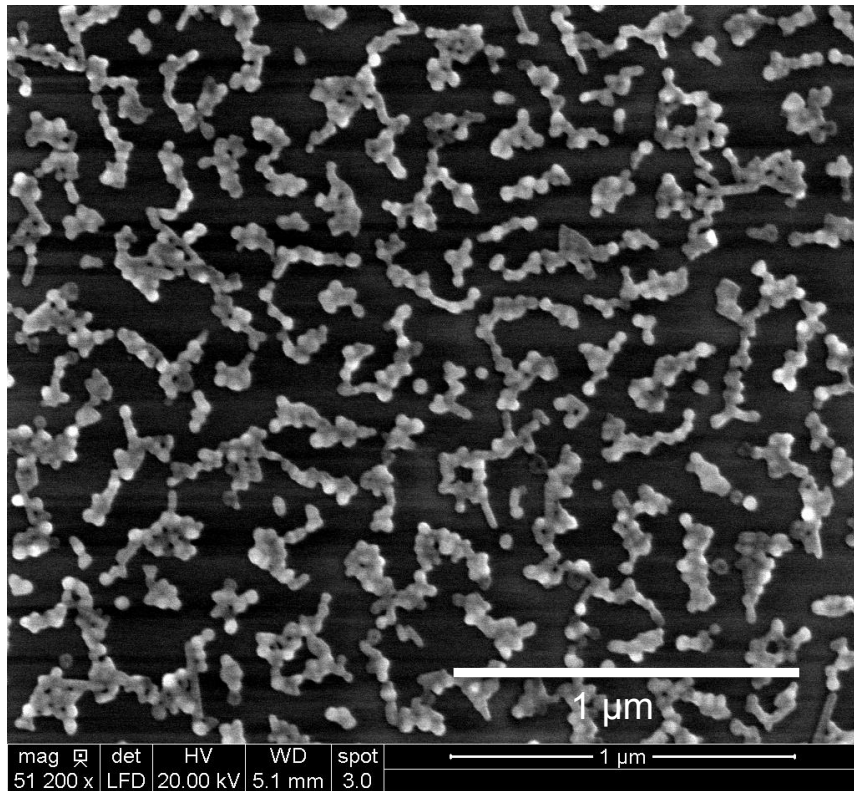
SEM images of Gold Nano-seeds on Glass



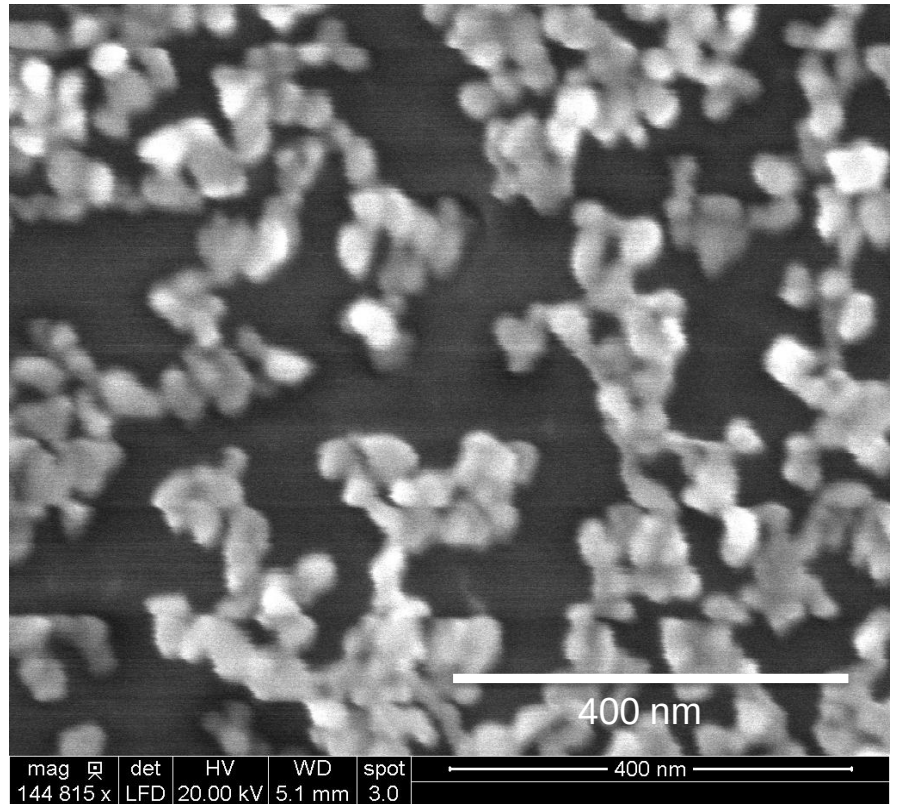
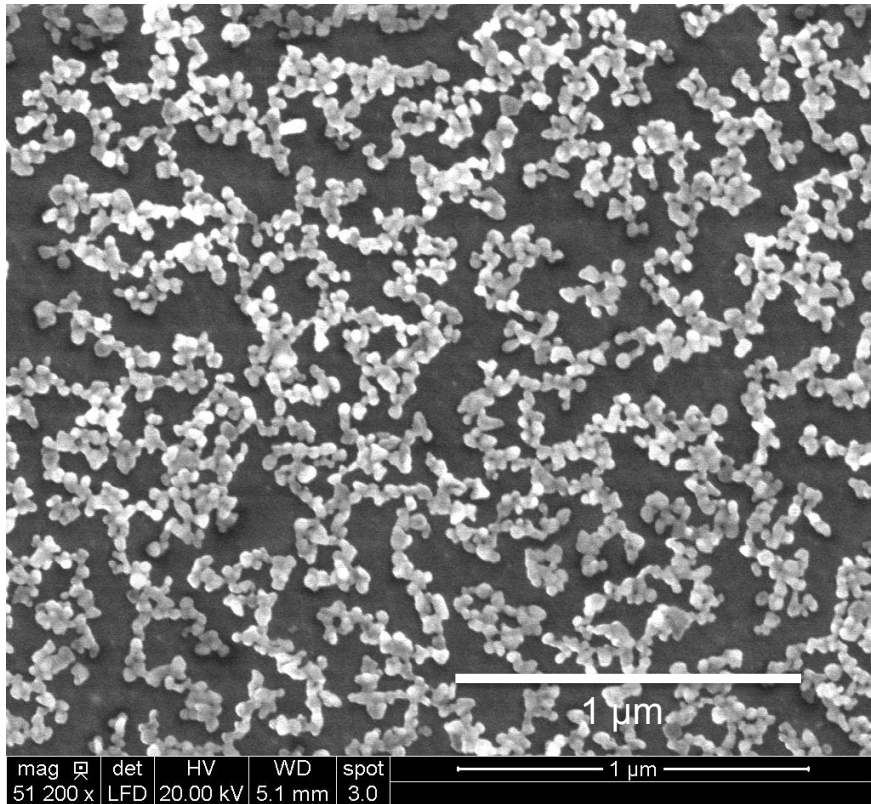
SEM images of Gold Nano-seeds on PET



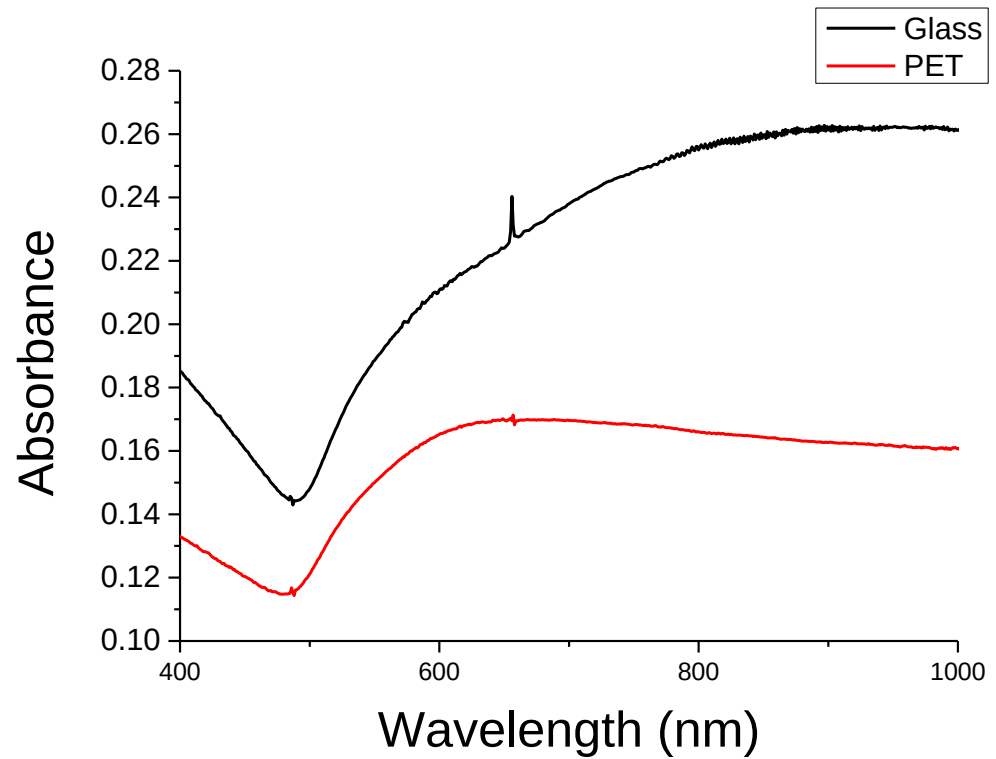
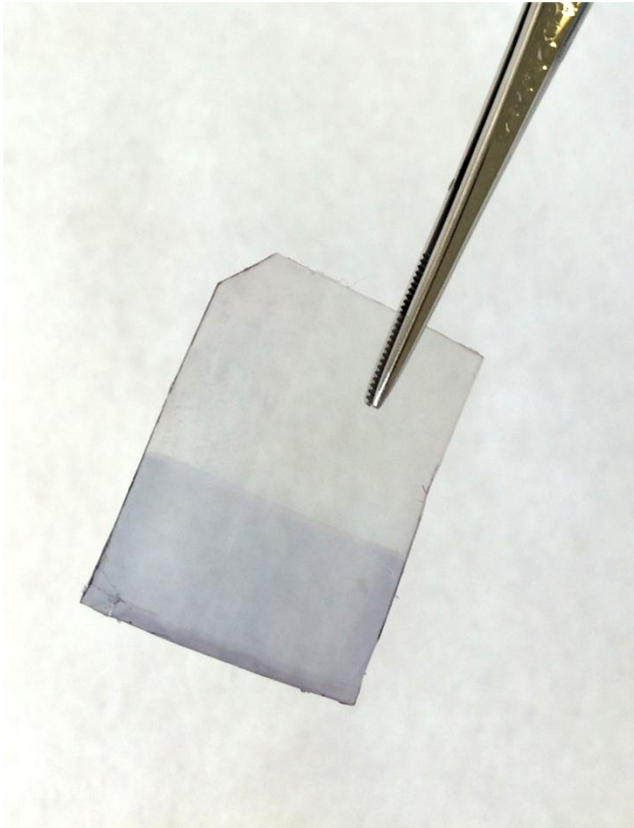
SEM images of Anisotropic Gold Nanostructures on Glass after Growth Step



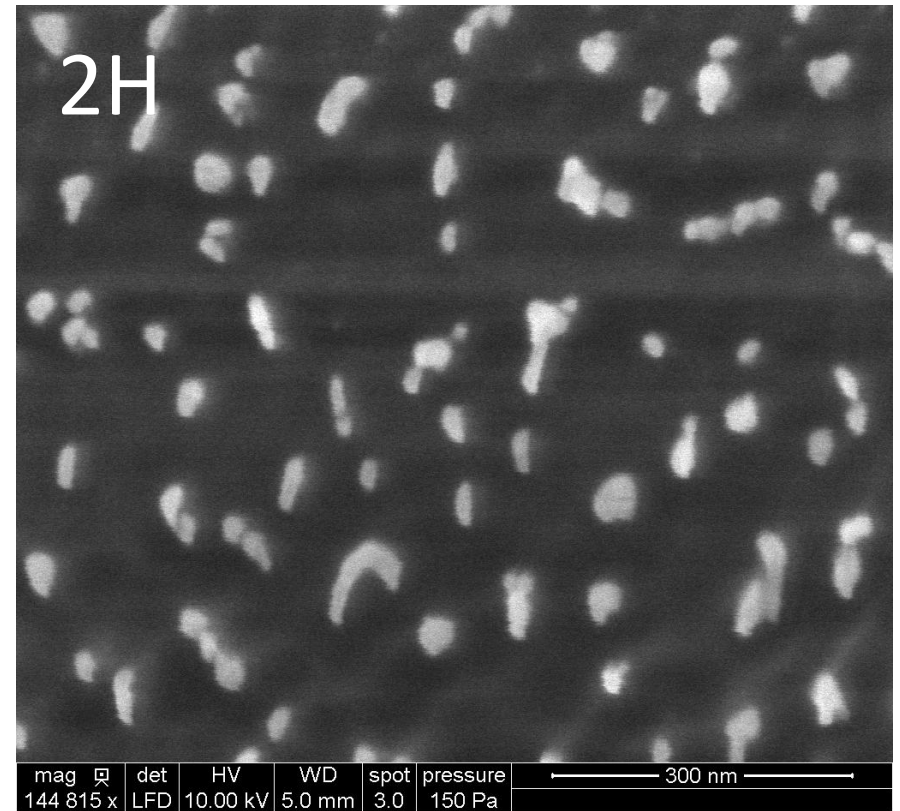
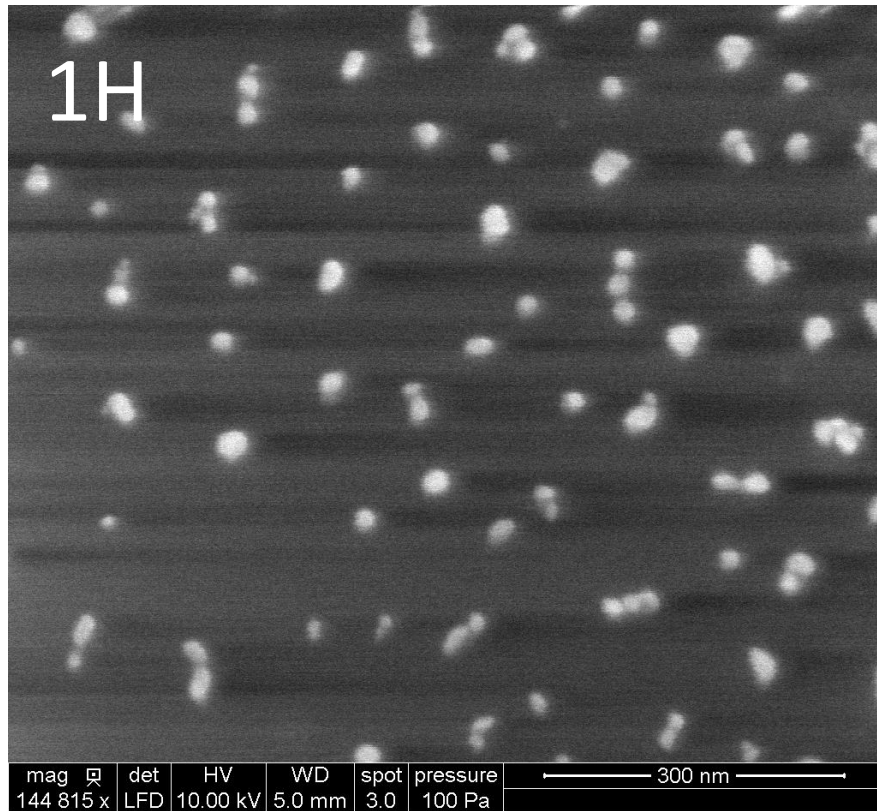
SEM images of Anisotropic Gold Nanostructures on PET Growth Step



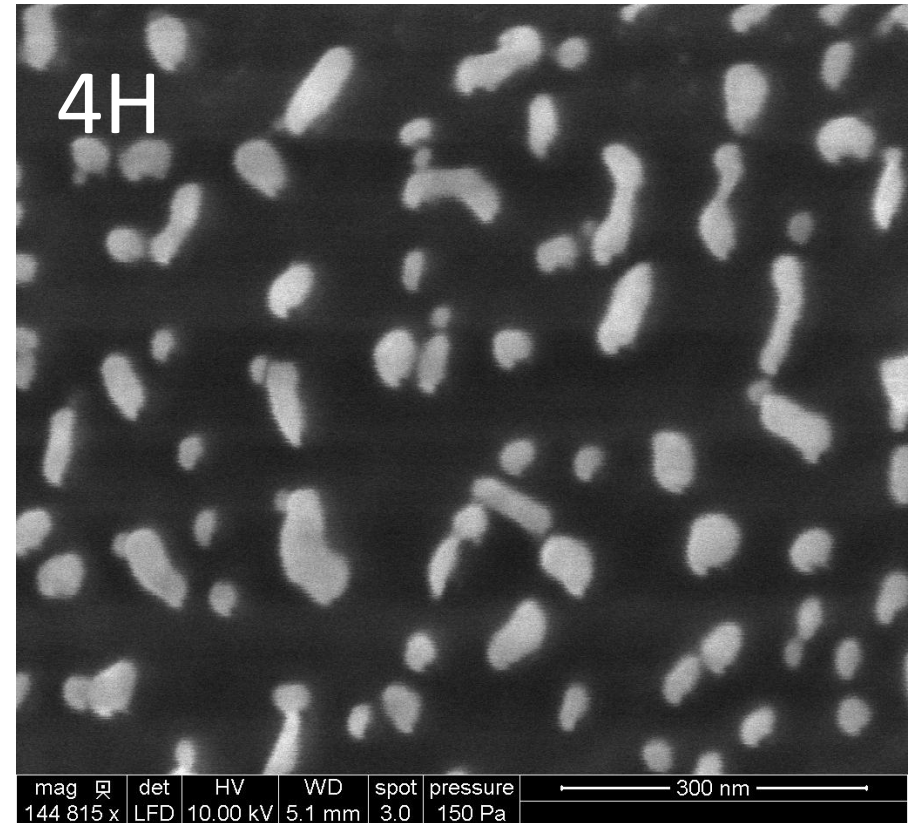
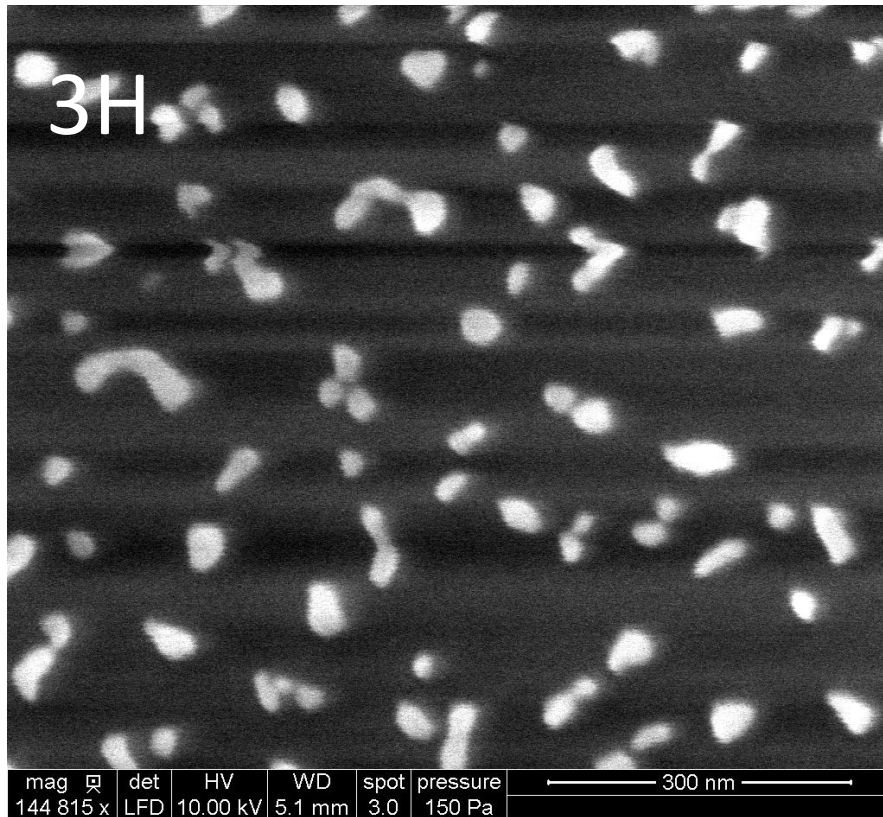
UV-VIS Spectra of Plasmonic Substrates after Anisotropic Growth



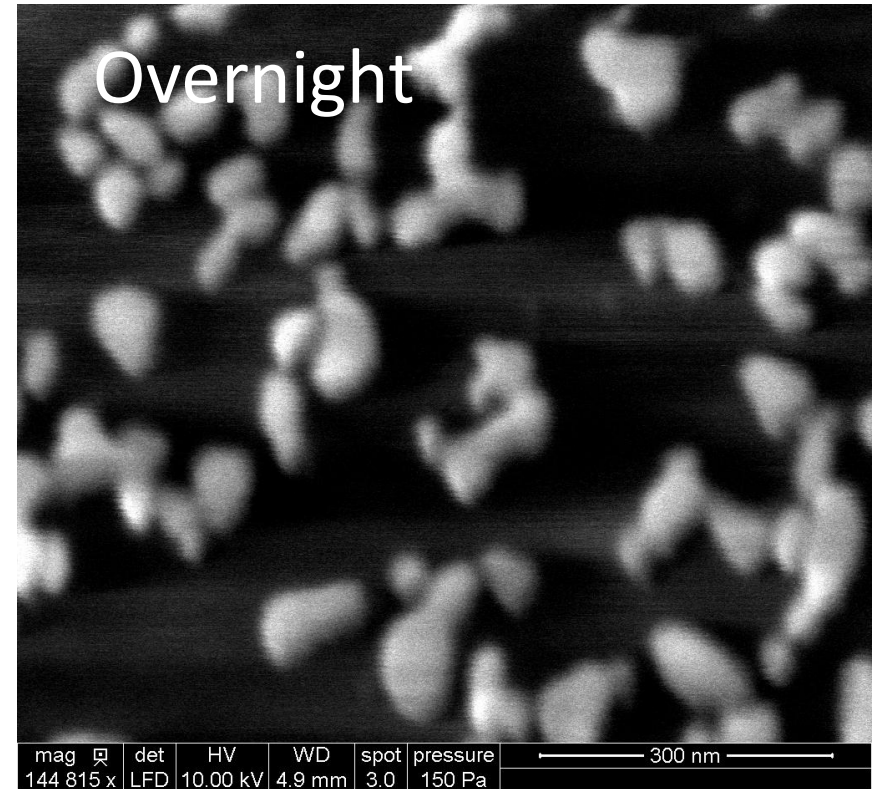
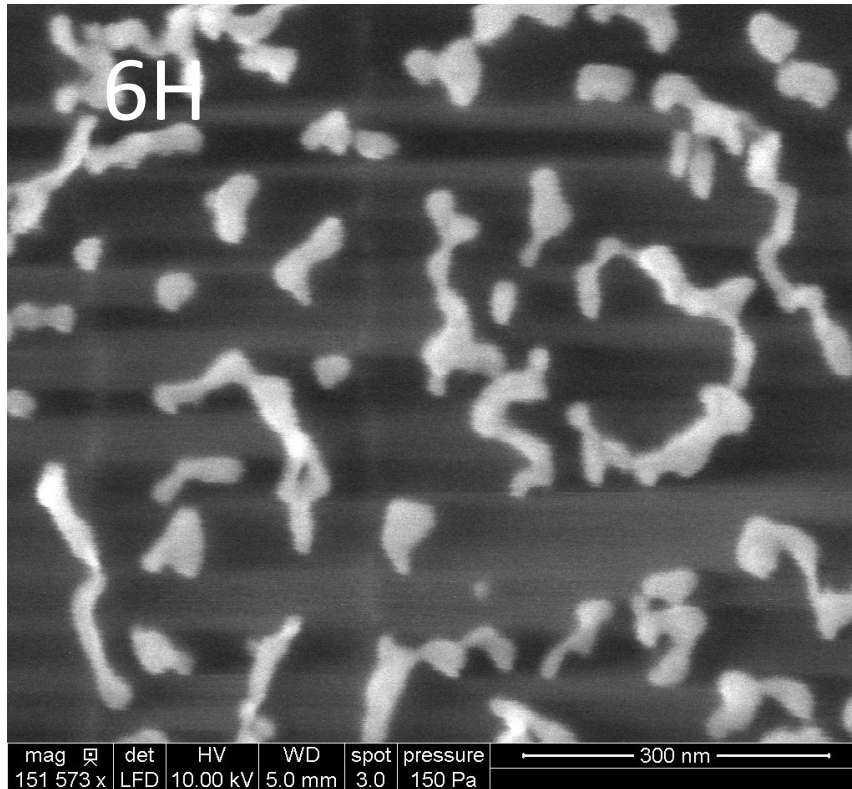
SEM Images of Gold Anisotropic Nanostructure Growth on PET



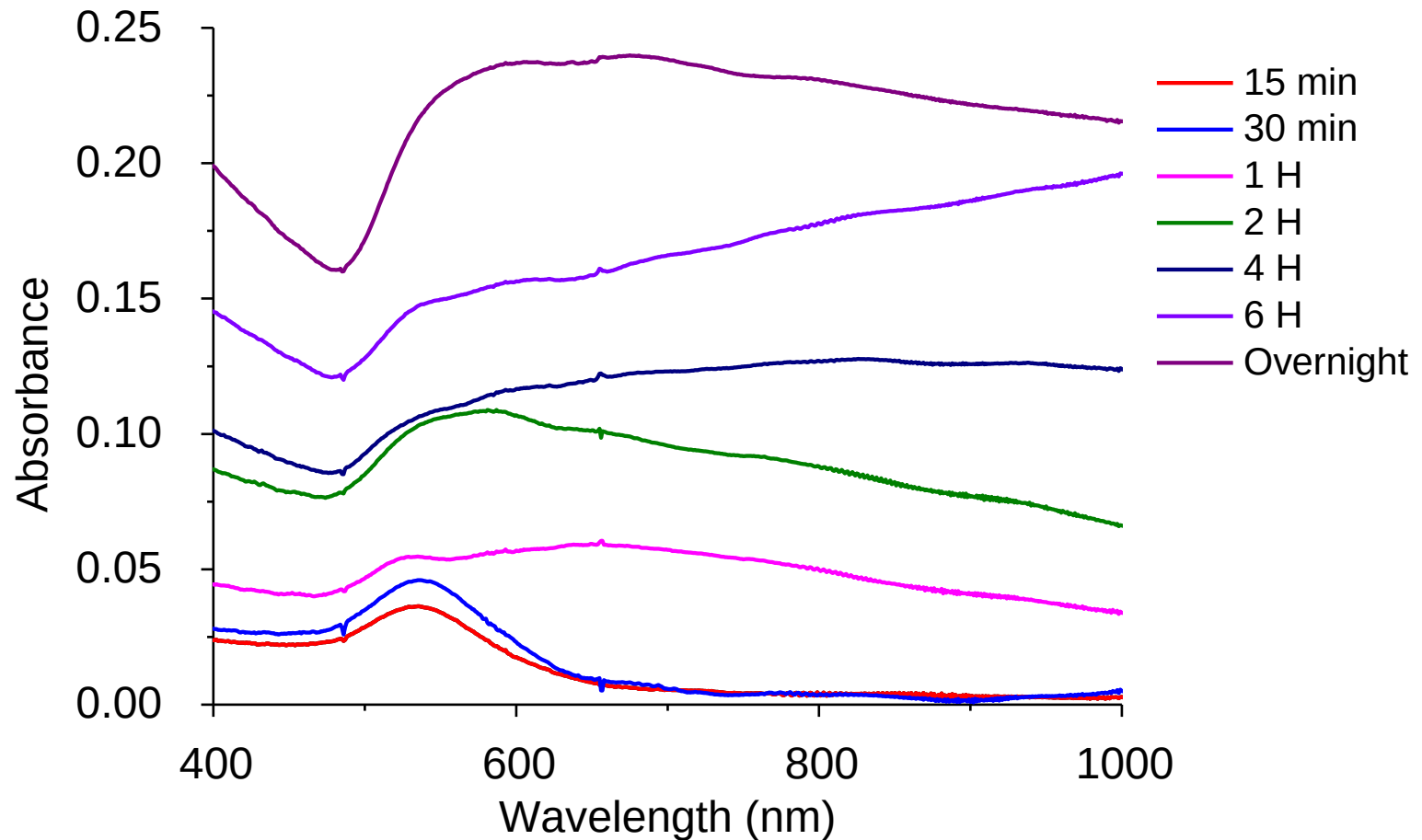
SEM Images of Gold Anisotropic Nanostructure Growth on PET



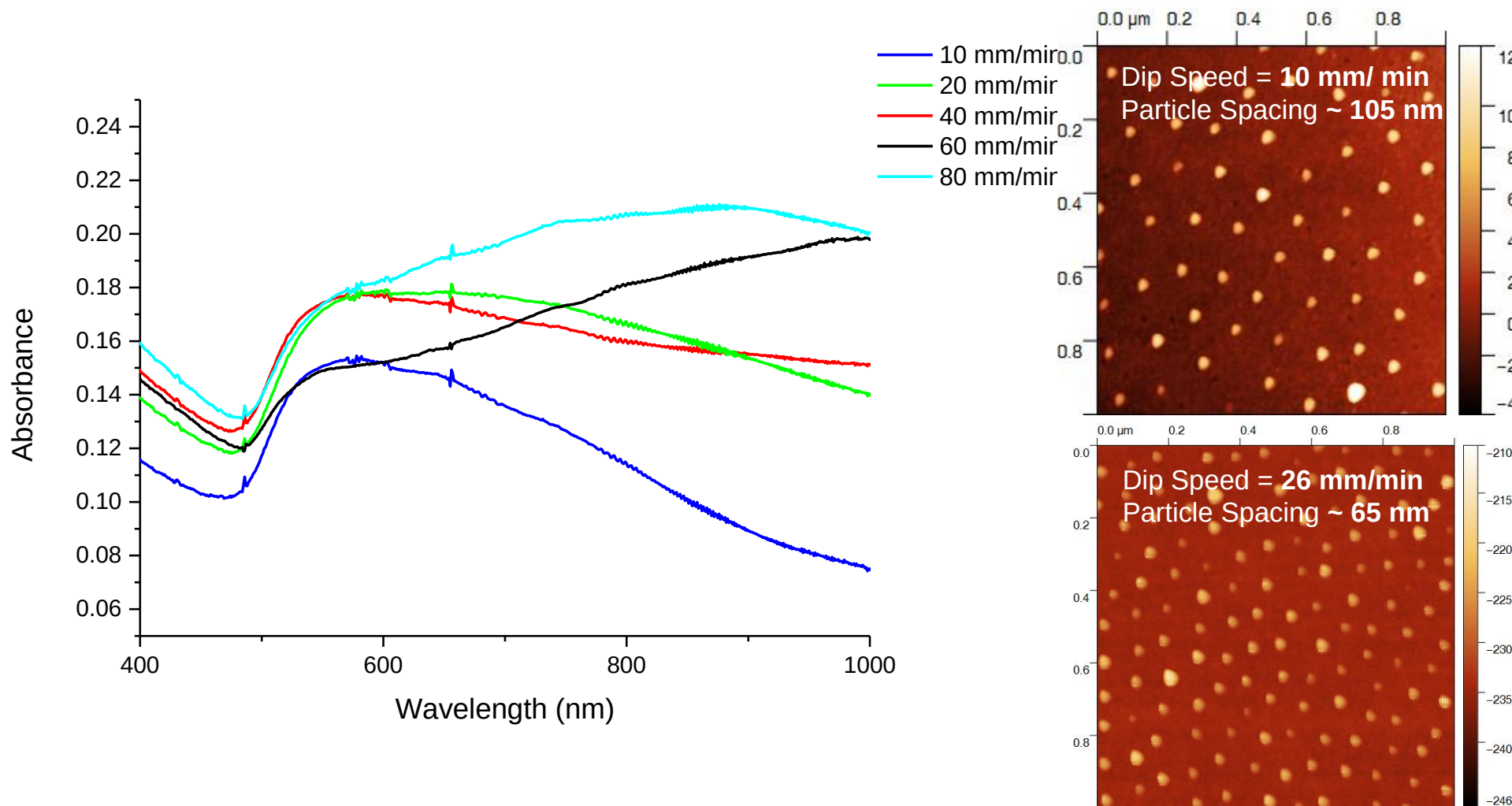
SEM Images of Gold Anisotropic Nanostructure Growth on PET



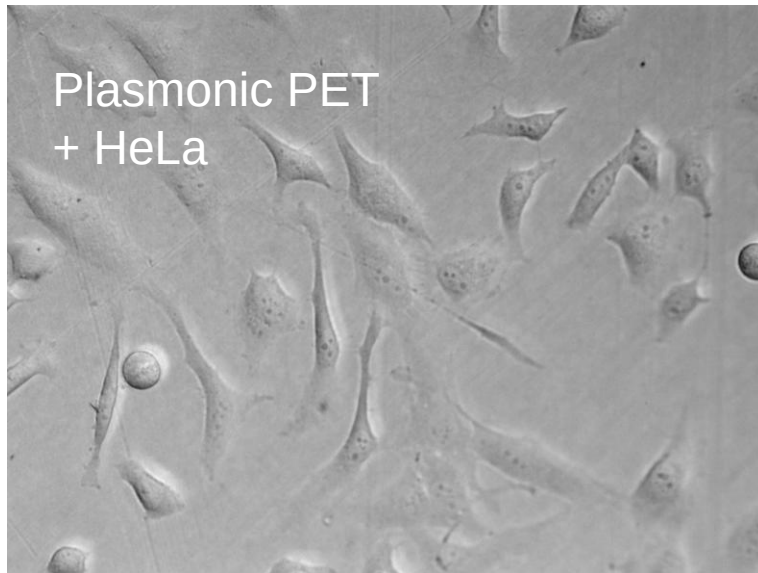
UV-Vis Spectra for Plasmonic PET Substrates as a Function of Reaction Time in Anisotropic Growth Step



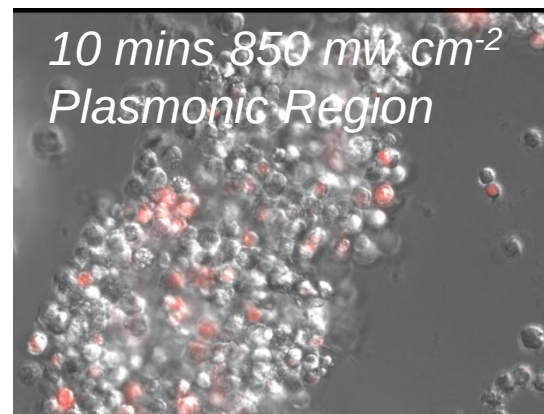
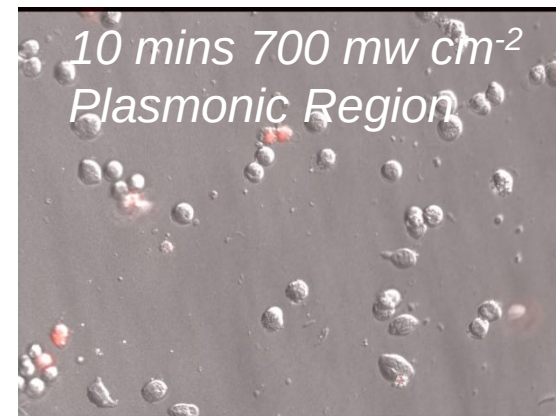
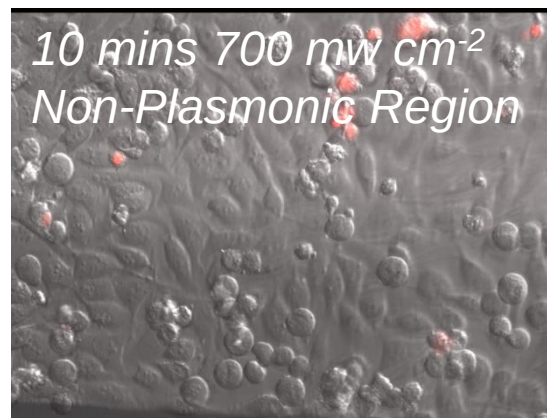
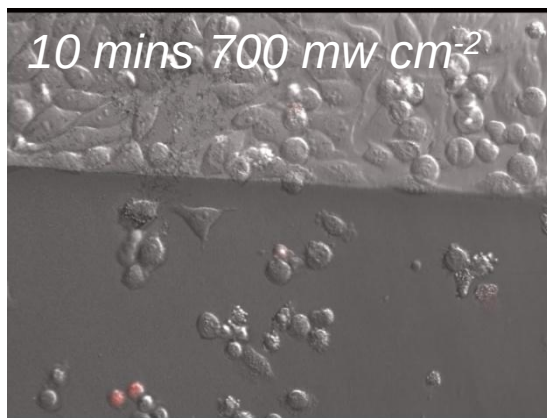
UV -Vis Spectra for Plasmonic PET Substrates as a Function of Dip-coating Speed



Cell Growth on Plasmonic Substrates



Cell Lift-off Experiments on Plasmonic Substrates

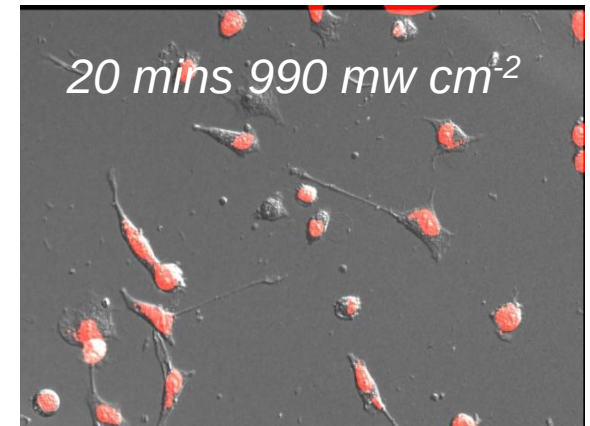
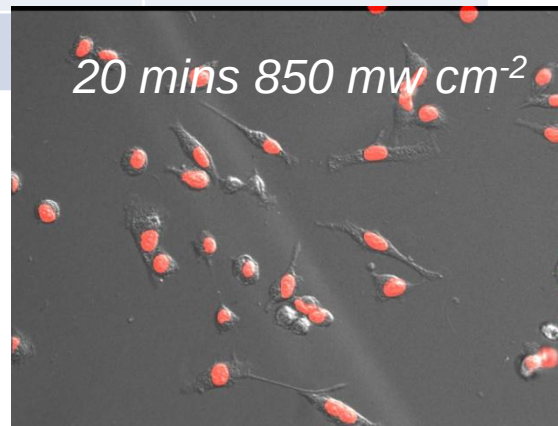
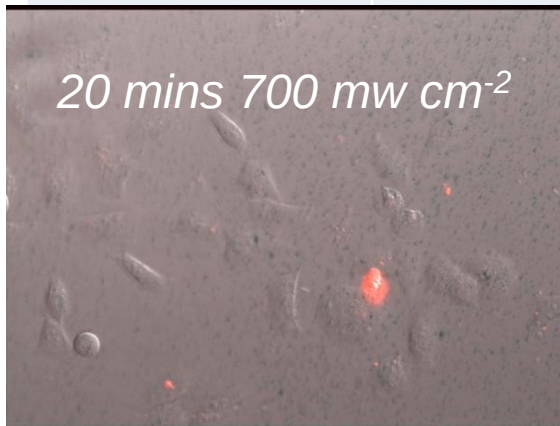


PI Staining Experiments with HeLa on Plasmonic Glass Substrates

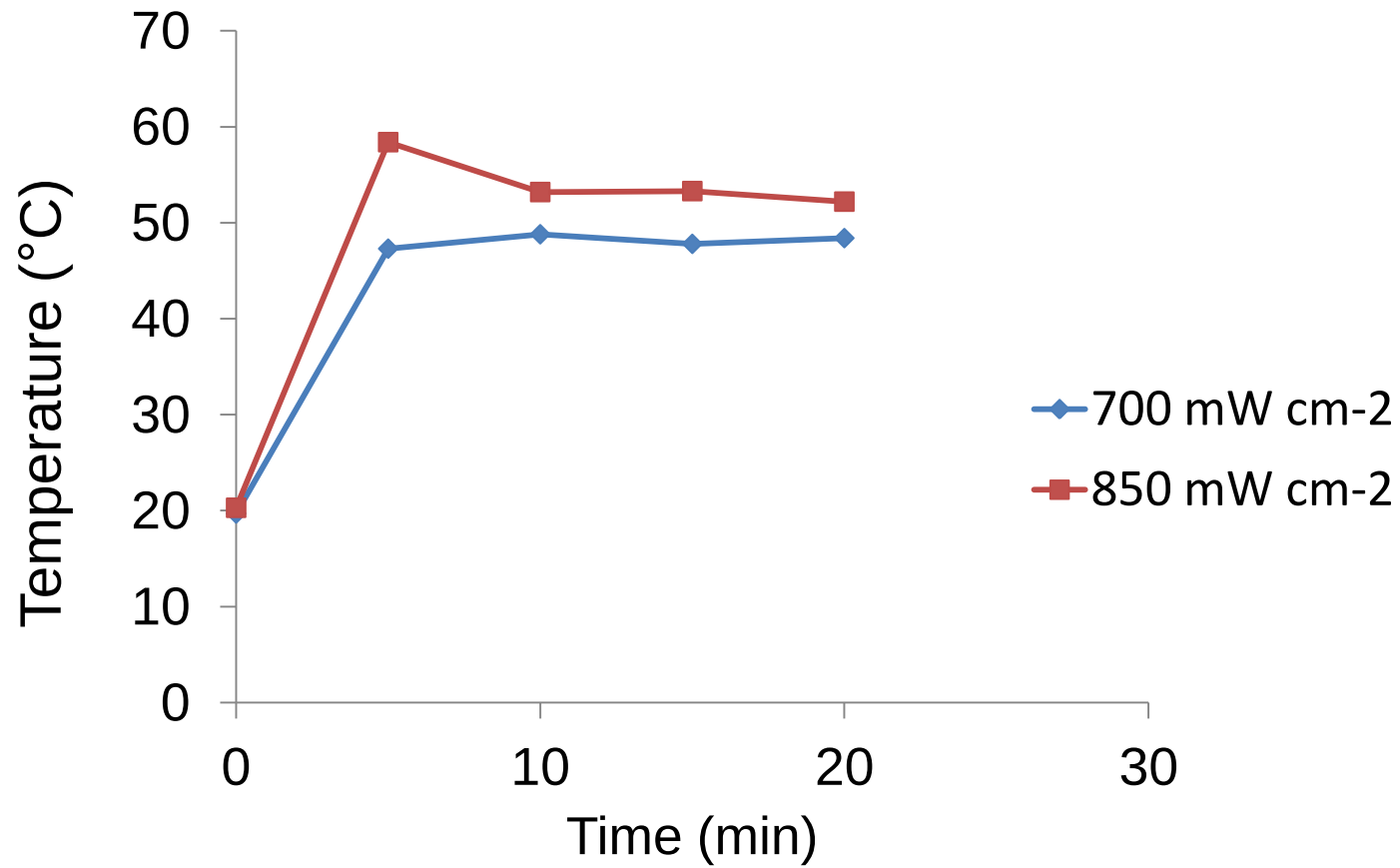
Dose	PI Staining	Lift-off
20 mins <700 mw cm ⁻²	Alive	No
20 mins 700 mw cm ⁻²	Mostly Alive	Some
20 mins 850 mw cm ⁻²	Dead	Some
20 mins >990 mw cm ⁻²	Dead	No

Coagulative Necrosis?

‘Irreversible cell damage occurs at around 40-45 °C after 30 to 60 minutes. At temperatures above 60 °C this time decreases exponentially’ *Nat Rev Cancer. 2014 Mar;14(3):199-208*



Heating of Cell Media on Plasmonic Glass Substrates.

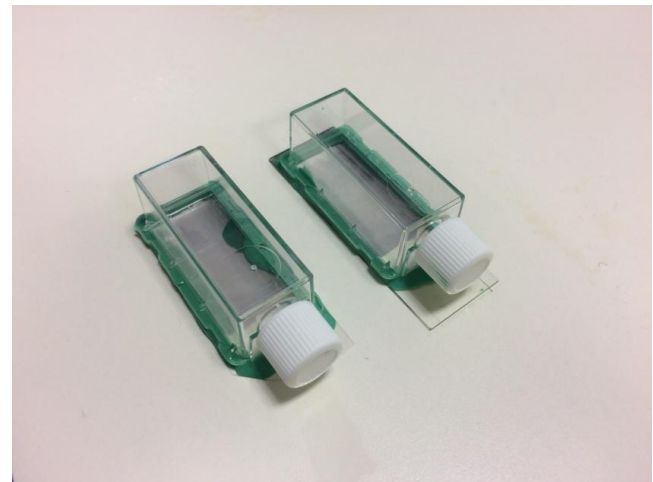


Conclusion

- Plasmonic PET substrates can be successfully fabricated.
- Plasmon band can be tuned by changing experimental conditions
- Cells can be successfully grown on these plasmonic substrates

Conclusion and Future Work

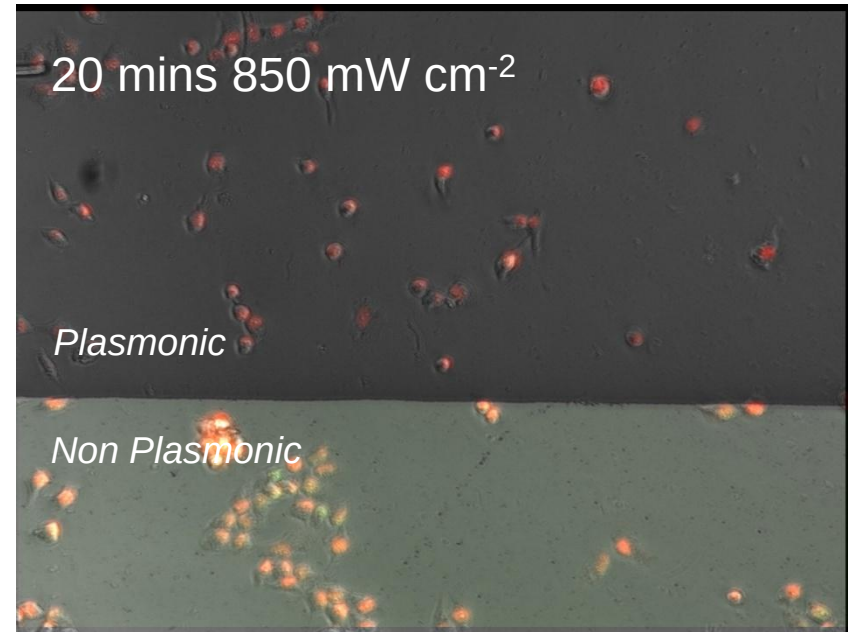
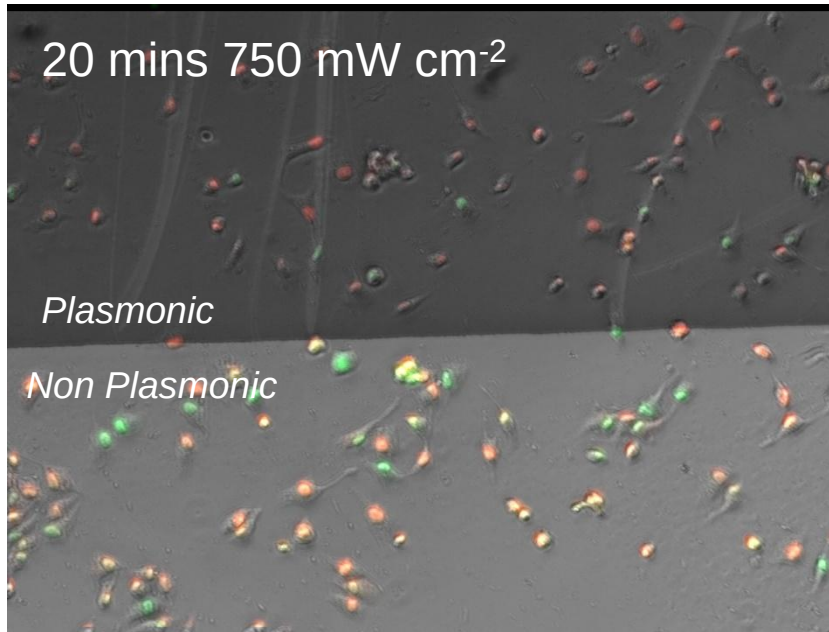
- Some cell lift-off, however cell death is a problem, most likely due to over heating of cell media.
- Currently studying effect of surface temperature on of cell death/ lift off
- Process is being scaled-up to coat 10s of cm of PET.



Thank you
Any Questions?

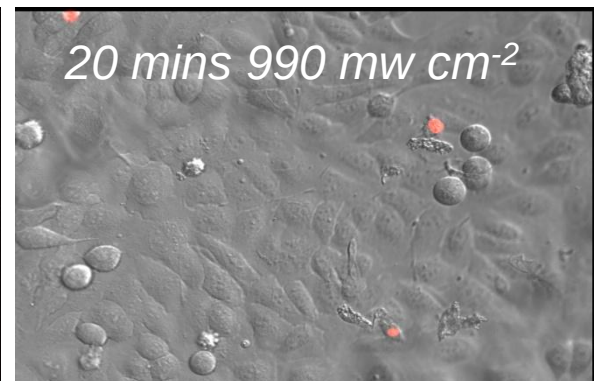
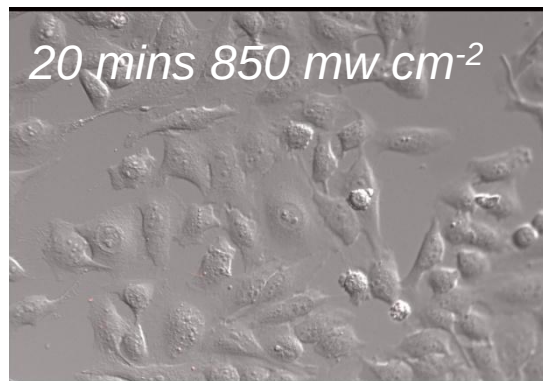
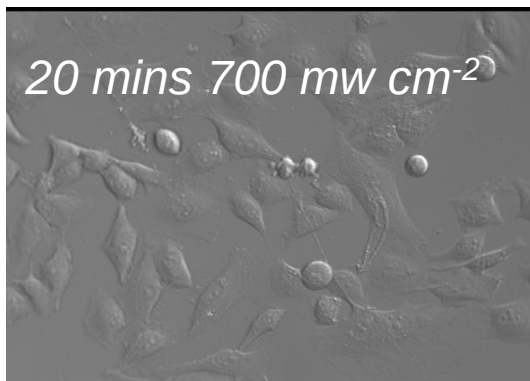
Live Dead Stain on Gold-Glass Boundary

Is Cell Death due to Local Heating or Heating of Media?

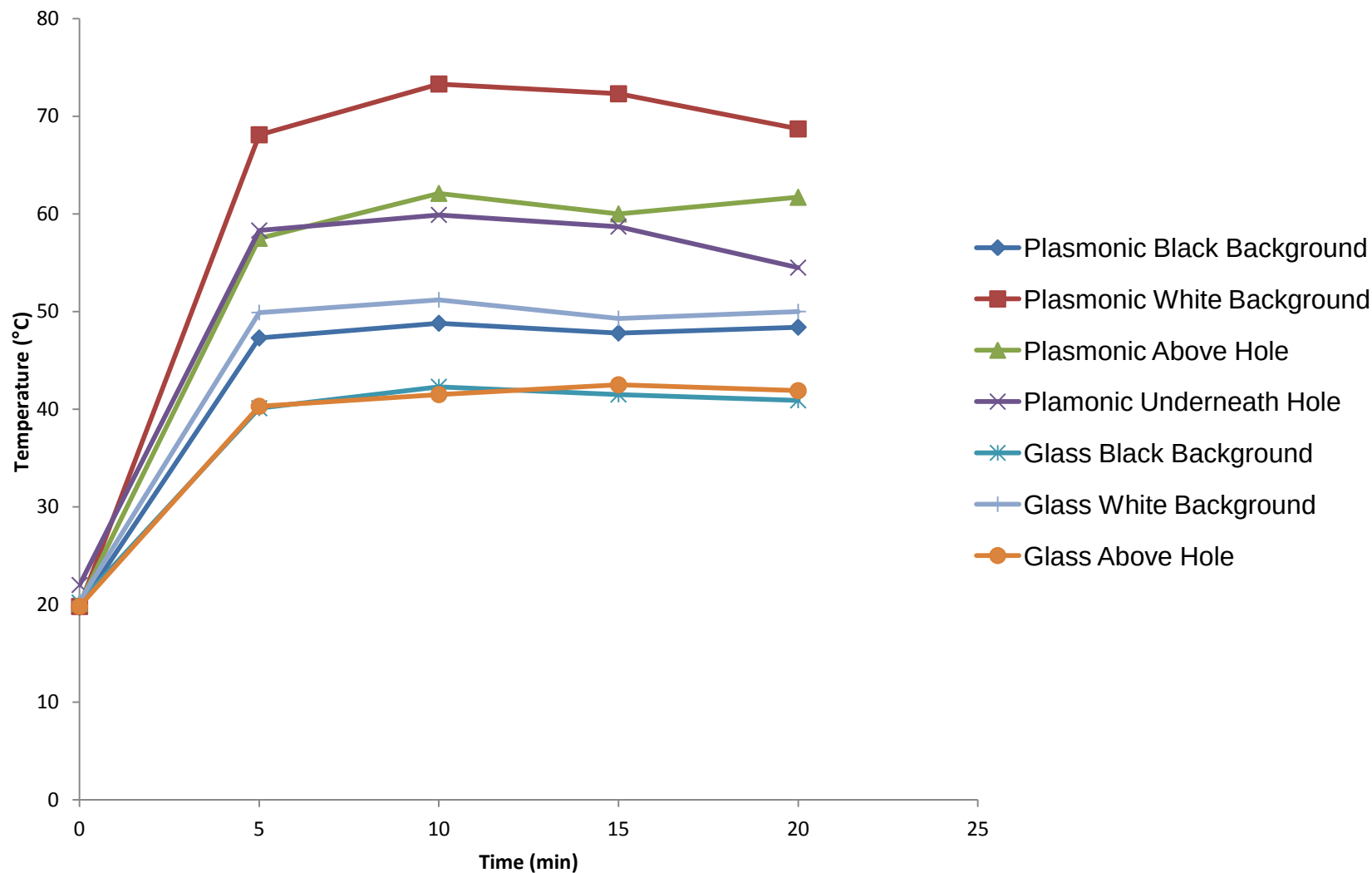


PI Stained HeLa on Glass Substrate Control

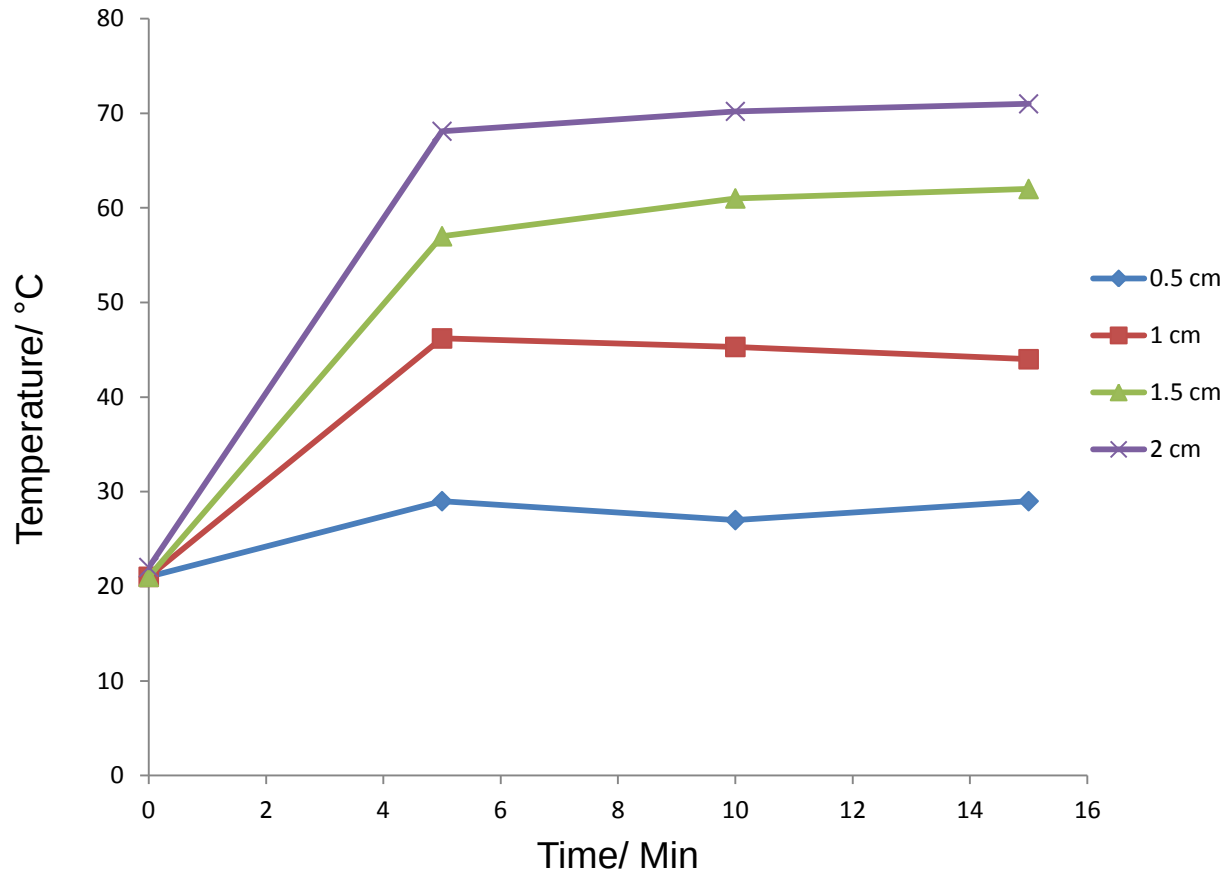
Dose	PI Staining	Lift Off?
20 mins 700 mw cm ⁻²	Alive	No
20 mins 850 mw cm ⁻²	Alive	No
20 mins 990 mw cm ⁻²	Alive	No



Heating of Cell Media on Plasmonic Glass Substrates at 700 mW cm⁻²



Dependence of Temperature on Spot Size at 1200 mWcm⁻²



•n.b According to notes Juanjo used 2.2 cm spot size

Heating of Cell Media on Plasmonic Glass Substrates at 700 mW cm⁻²

