Plasmonic coupling in lysozyme-gold nanodispersions and on hybrid films

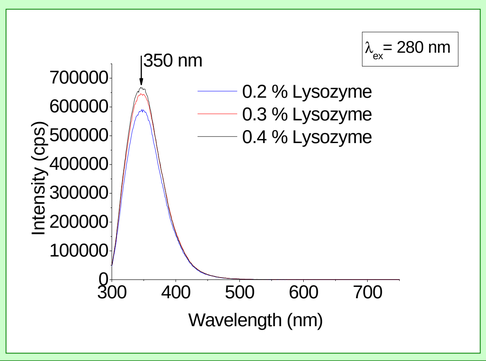
G. Bohus[1, *], M. Benkő[1], N. Ábrahám[1], I. Dékány[1,2]

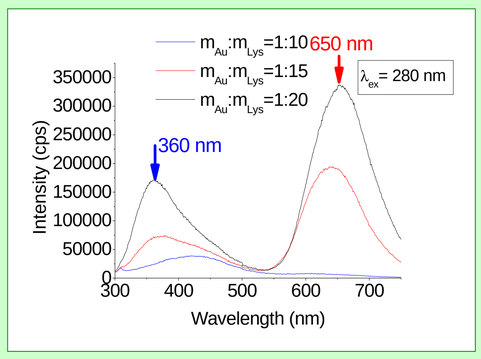
[1] *Supramolecular and Nanostructured Materials Research Group of the Hungarian Academy of Sciences, University of Szeged, Hungary*
[2] *Department of Medical Chemistry, University of Szeged, Hungary*
[*] *e-mail: bohusgabriella@gmail.com*

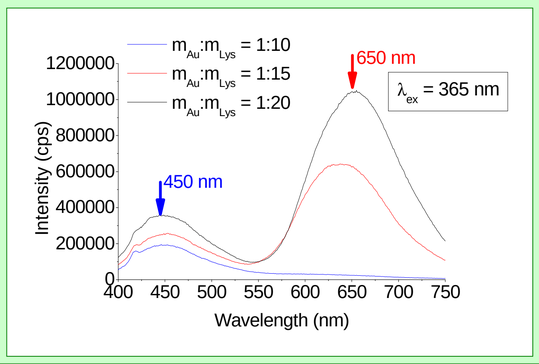
ABSTRACT

Lysozyme stabilized gold nanodispersions and bilayered lysozyme-gold nanorod films were investigated. It has recently come to our attention that gold nanoparticles and nanorods can influence the fluorescence properties of lysozyme due to plasmonic coupling. The emission peak of lysozyme solution is around 350 nm, but by creating lysozyme-gold nanoparticle a new emission peak appears around 650 nm and the emission of the lysozyme shifts to 360 nm, and the particles also can be excitated at 365 nm, where the lysozyme has no emission peak. The lysozyme-Au nanorod films were prepared in two different ways. First we prepared lysozyme and Au nanorod films layer by layer on a glass substrate. In the second method the Au nanorods were grown onto the glass substrate and the Au rods functionalized by lysozyme. The emission peak of the lysozyme shifted to 460 nm and a new emission peak appeared at around 670 nm. It is possible that a plasmonic coupling took place between the Au rods and the lysozyme and this is responsible for the altered emission spectrums.

FLUORESCENCE PROPERTIES

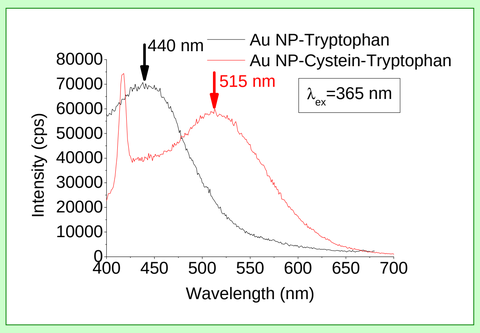




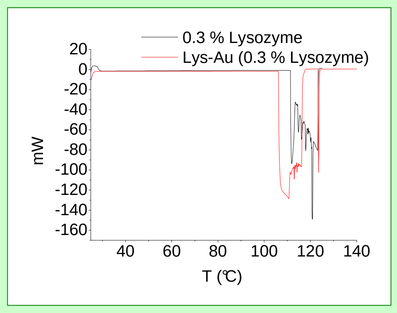


In this work plasmonic coupling effect of Au nanoparticles and lysozyme was investigated with fluorescence spectroscopy. Lysozyme-Au nanoparticles have an intense emission peak at 650 nm, and also these nanoparticles can be excitated at different wavelengths than lysozyme. At the excitation wavelength 365 nm the lysozyme has no emission peak, but the Lysozyme-Au nanoparticles have two emission peaks at 450 nm and 655 nm due to plasmonic coupling. In Lysozyme-Au nanoparticles the plasmonic coupling between Au particle and tryptophan cause these two emission peak at λ_{ex}=360 nm.

MODIFIED EMISSION SPECTRA AND STABILITY

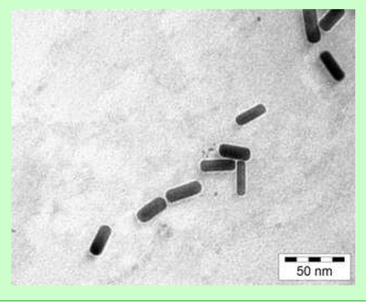


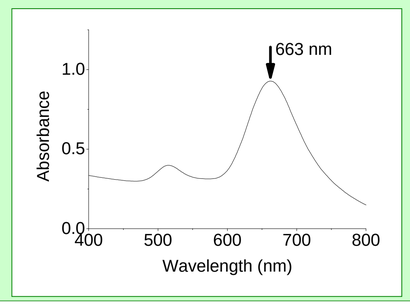
Tryptophan-Au particles have an emission at 440 nm and it red shifts when cysteine is introduced. The main emission peak is at 515 nm.

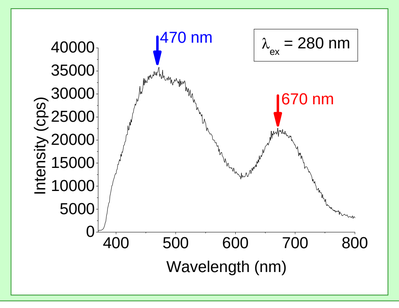


The presence of Au particle destabilizes the lysozyme, because Lys-Au particle has a smaller denaturation temperature.

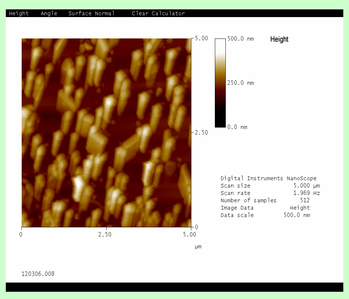
FLUORESCENCE PROPERTIES WITH Au NANORODS

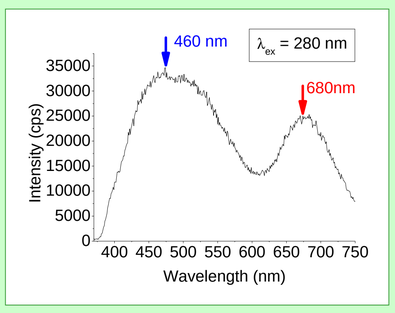






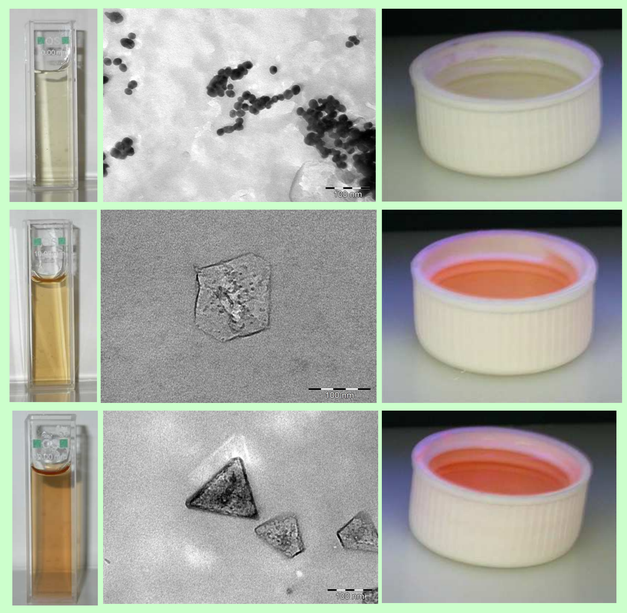
Au rods were functionalized with PSS in order to prepare lysozyme/Au rod layer by LBL method. Though several layers were created, the emission spectra of the film remained the same. The new emission peaks appeared after the first layer was completed and it's intensity reamied the same which indicates that the appropiate distance for plasmonic coupling is reached in the first layer.





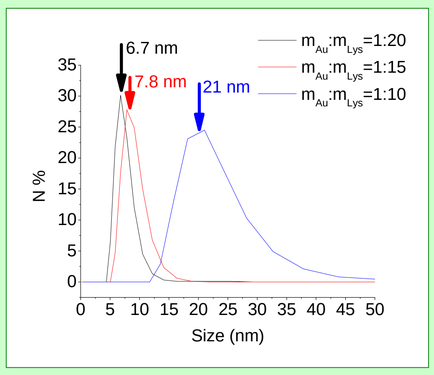
The emission spectra of the Au rods functionalized with lysozyme resembles the lysozyme/Au rod layer's. The is probably because the disctence between Au particles and tryptophan are similar.

MORPHOLOGY



Top: m_{Au}:m_{lys} = 1:10, Middle: m_{Au}:m_{lys} = 1:15, Bottom m_{Au}:m_{lys} = 1:20

TEM images were taken of the samples. With the increasing amount of lysozyme the size of the Au nanoparticles decrease. Au nanoparticles size decreases with the increasing amount of lysozyme.



The size of the particles was measured with DLS and they correlate well with the TEM results.

CONCLUSION

- **The emission spectra of the lysozyme can be altered by Au nanoparticles due to plasmon coupling effect with tryptophan. The lysozyme-Au nanoparticles can be excicated at a different wavelength than lysozyme.**
- **The modified emission wavelength of tryptophan depends on the neighbouring amino acids and the size and the morphology of the Au nanoparticle. This distance can be enhanced with polymers or surfactants.**
- **Plasmonic couplig of lysozyme with Au nanorods is also possible.**

ACKNOWLEDGEMENT

The publication/presentation is supported by the European Union and co-funded by the European Social Fund, project number: TÁMOP-4.2.2/B-10/1-2010-0012.

National Development Agency
www.ujszechenyiterv.gov.hu
06 40 638 638

HUNGARY'S RENEWAL

The project is supported by the European Union.