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Monometallic and Bimetallic Platinum-containing nanoclusters for biomedical applications

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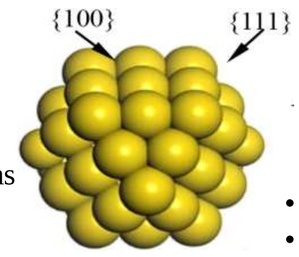
INTRODUCTION & BACKGROUND

Importance of metallic nanoclusters(NCs)



- Noble-metal NCs consisting of several atoms have been gaining much attention as novel fluorescent markers owing to their optical properties, which include size-dependent emission wavelength.
- Low toxicity, bioavailability, photostability as well as tunable size, composition, and optoelectronic properties of **NCs** make them suitable for various applications.

Why Pt NCs?

Platinum NCs are less cytotoxic(as in case of Au), and emit a brighter fluorescence at 470 nm. They are highly suitable for various applications including catalytic activity, bioimaging, anti-bacterial, anti-cancerous and anti-oxidant properties.

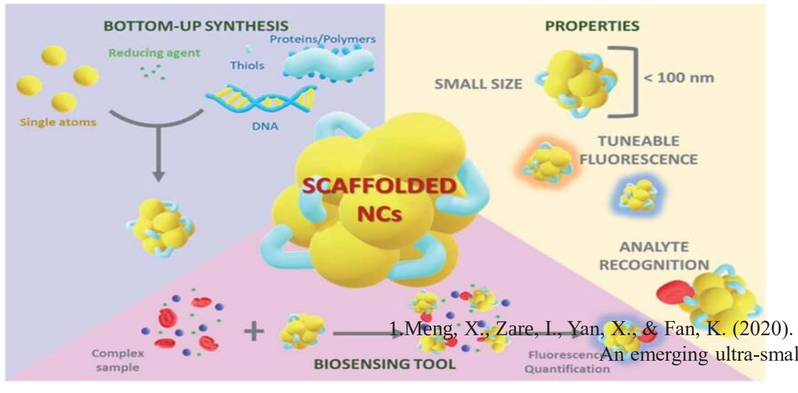
1.*Meng, X., Zari, I., Yan, X., & Fan, K. (2020). Protein-protected metal nanoclusters: An emerging ultra-small nanozyme.*

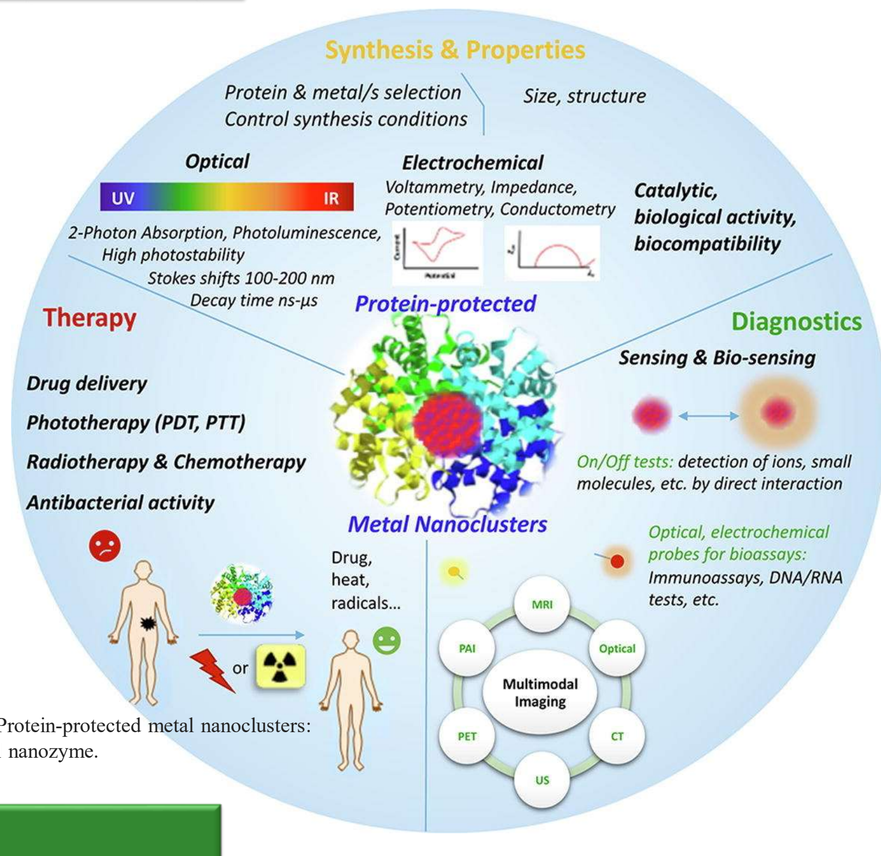
2. Nonappa, N. (2020). Luminescent gold nanoclusters for bioimaging applications. Beilstein Journal of Nanotechnology, 11, 533-546

3. Tanaka, S. I., Miyazaki, J., Tiwari, D. K., Jin, T., & Inouye, Y. (2011). Fluorescent platinum nanoclusters: synthesis, purification, characterizat and application to bioimaging. , 123(2), 451-455.

Importance of protein protected NCs

- Excellent fluorescent labels for biomedical applications
- Protein molecules protect clusters for aggregation.
- Good biocompatibility and bioactivity.
- Multifunctionality.
- High enzymatic activity





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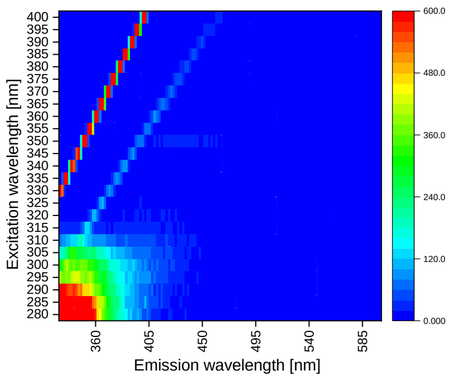
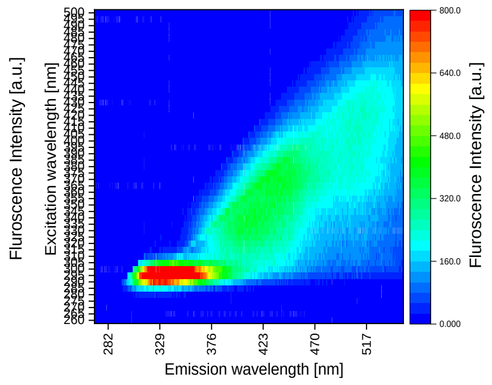
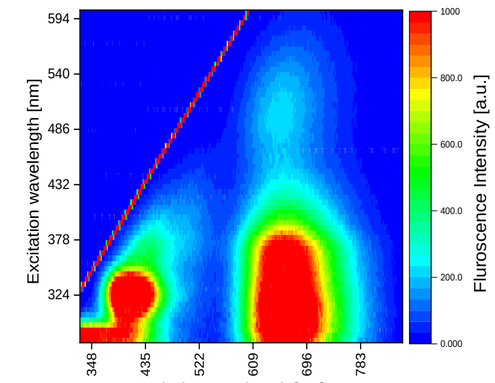
RESULTS & DISCUSSION



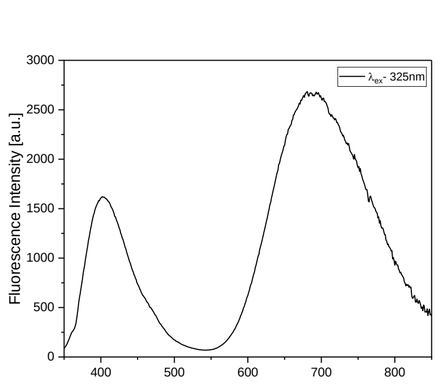
Fluorescence emission maps of tyrosine and Pt-tyrosine systems. In native tyrosine, there was not fluorescence emission other than the autofluorescenece of tyrosine. By introducing Pt into system, there is emission spot at around 410nm.



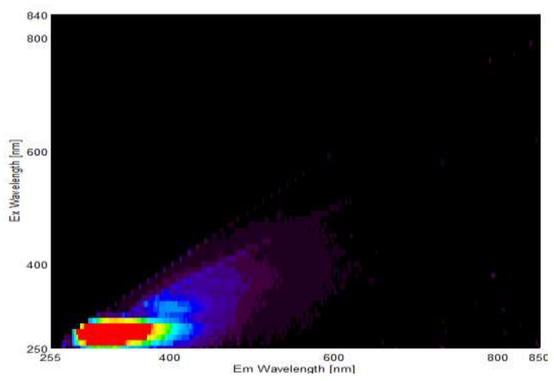
Fluorescence emission maps of BSA-AA and BSA-Pt-AA systems. In native BSA-AA system, fluorescence emission is around 420nm with much less intensity. With addition of Pt, emission moved towards 438nm and increased intensity.



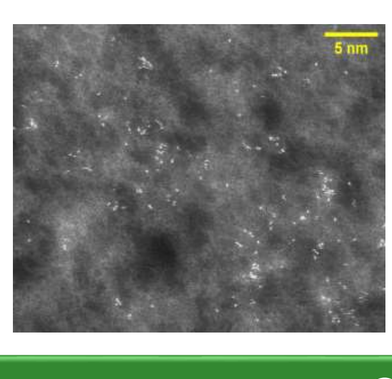
Fluorescence emission maps of BSA-Au and BSA-Au-Pt system. Fluorescence is quenched by the addition of Pt into the monometallic system. It can be due to generation of charge transfer complexes. The molecule that should fluoresce(Au) is quenched due to a transfer of energy from the lowest excited singlet state to another electronic state of the metal, resulting in loss of fluorescence.

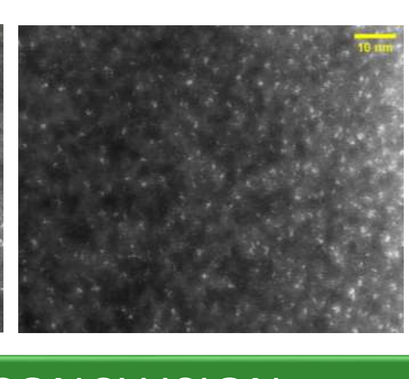


Fluorescence emission spectra of BSA-Au and BSA-Au-Pt system



Fluorescence emission maps of BSA-Pt systems after 1 and 25 daya. Fluorescence emission at around 454nm appeared with time. This is may be due to slow reduction of Pt by BSA.



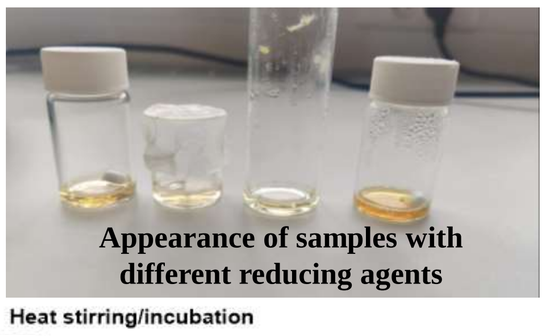


HR-TEM images of Pt nanoclusters

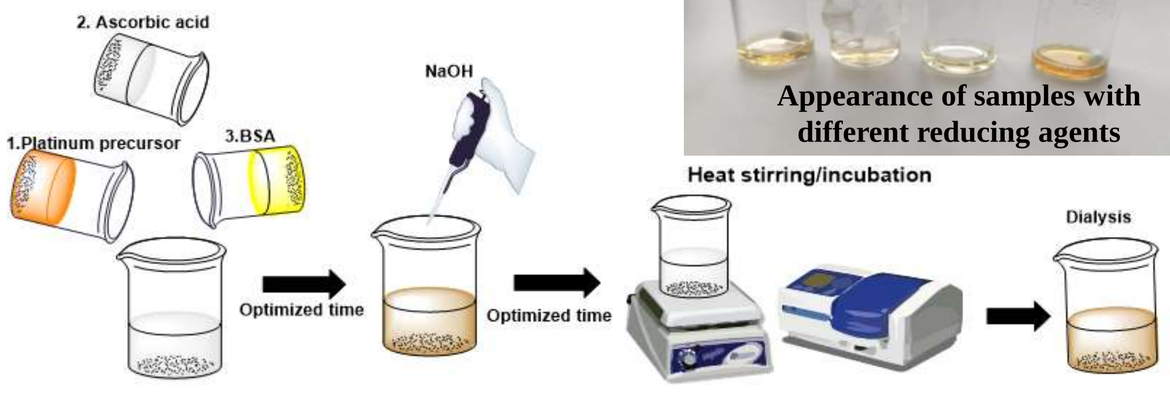
METHOD

One pot green synthesis of metallic NCs

- Preparation of aqueous solutions of Platinum, Gold and stabilizing agent.
- Vortexed mixing of predetermined volumes of all precursors with optimized time durations.
- Incubation of sample at 70C for 5hours.
- Purification of samples.



Appearance of samples with different reducing agents



CONCLUSION

- High resolution images are showing the production of metallic nanoclusters.
- In case of BSA-Pt-AA, fluorescence contribution can be from oxidized part of BSA and platinum together.
- In case of tyrosine-Pt system, fluorescence was observed after addition of Pt in system which then oxidized the tyrosine(bi-tyrosine).
- In case of bimetallic system, fluorescence is presumably quenched when Pt was introduced.

FUTURE WORK

- Analysis of conformational changes of BSA protein after addition of Pt through circular dichroism.
- Optimizations of synthesis parameters of bimetallic nanocomposites.
- Cell viability tests and fluorescence imaging of cancerous and non-cancerous cells.