Saratov Fall Meeting
Nanobiophotonics XVI conference

Synthesis of fluorescent nanostructures based on L-aspartic acid with various additives

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Introduction

1. Fluorescent nanostructures (FNS)

FNS are divided by composition into:

Nonorganic

- Semiconductor quantum dots;
- Metal nanoclusters;
- Silicon nanoparticles

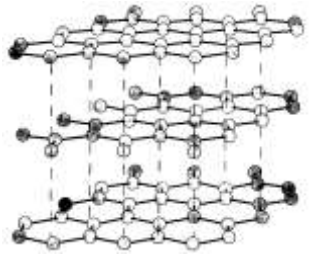
Organic

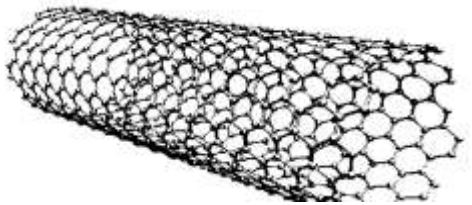
- Polymer nanoparticles modified with fluorescent dyes;
- Nanopatricles with aggregation-induced emission;
- FNS based on carbon-containing materials

Hybrid

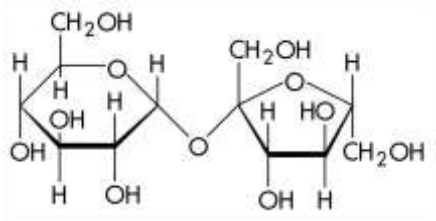
2. Methods for the synthesis of fluorescent nanostructures based on carbon-containing materials

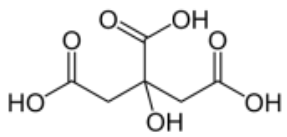
«Top-down»

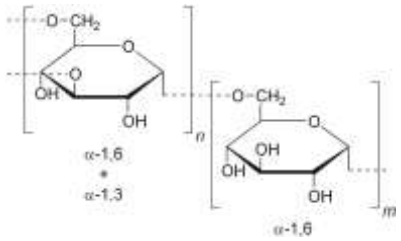




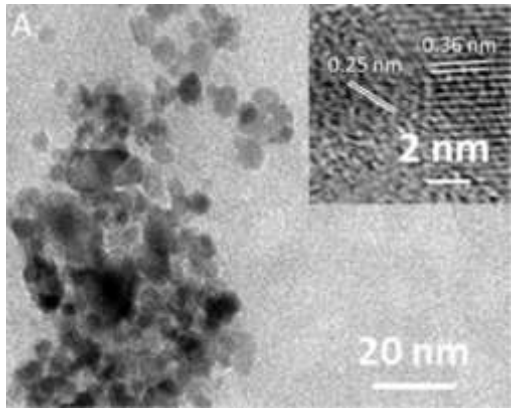
FNS





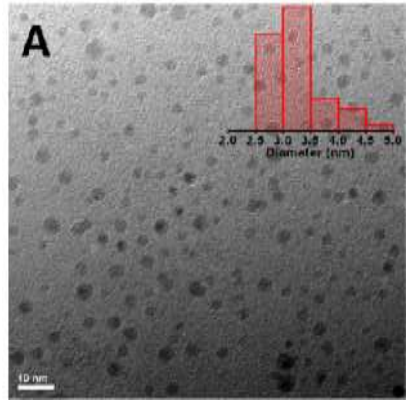


Different organic precursors



TEM image of carbon nanoparticles obtained by microwave method based on ammonium citrate[1]

«Bottom-up»

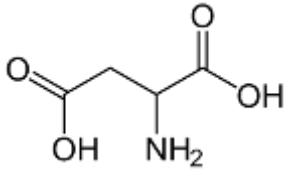


TEM image of fluorescent nanoparticles based on L-aspartic acid and D-glucose[2]

Experimental section

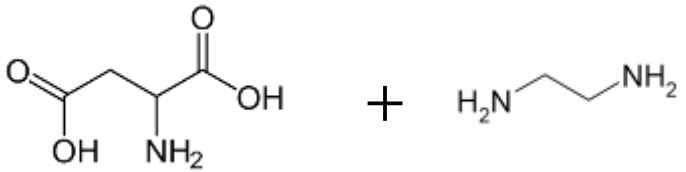
Synthesis and characterization of FNS

1



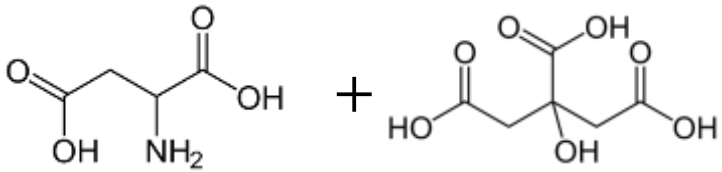
L-aspartic acid 0.1 M

2



L-aspartic acid 0.1 M + 1,2-ethelendiamine 0.1M

3



L-aspartic acid 0.1 M + citric acid 0.1M

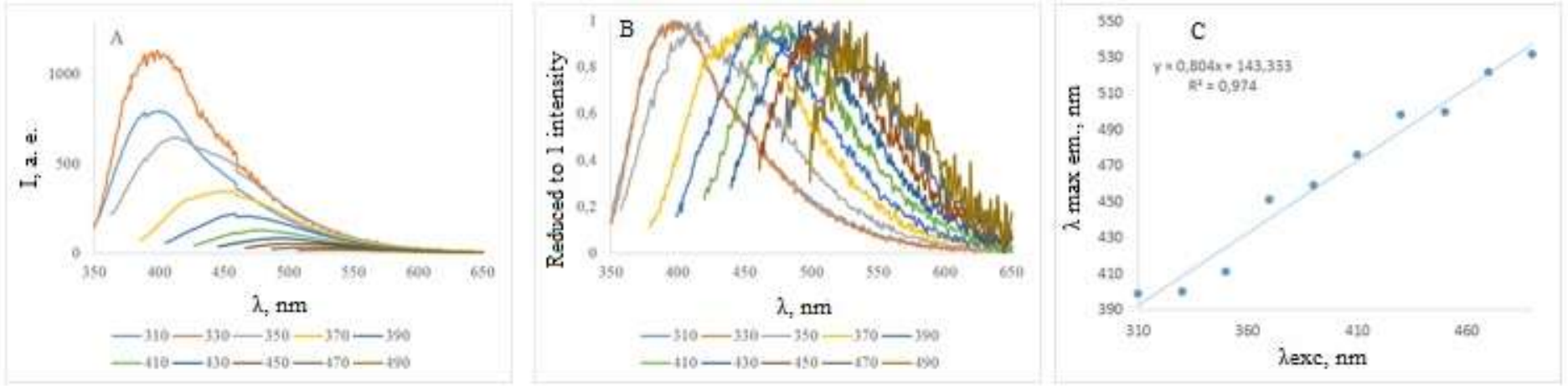
Hydrothermal synthesis for 2 or 3 hours at 200 ºC

- Measurement of fluorescence spectra at different excitation wavelengths
- Influence of treatment time and additives on fluorescent properties

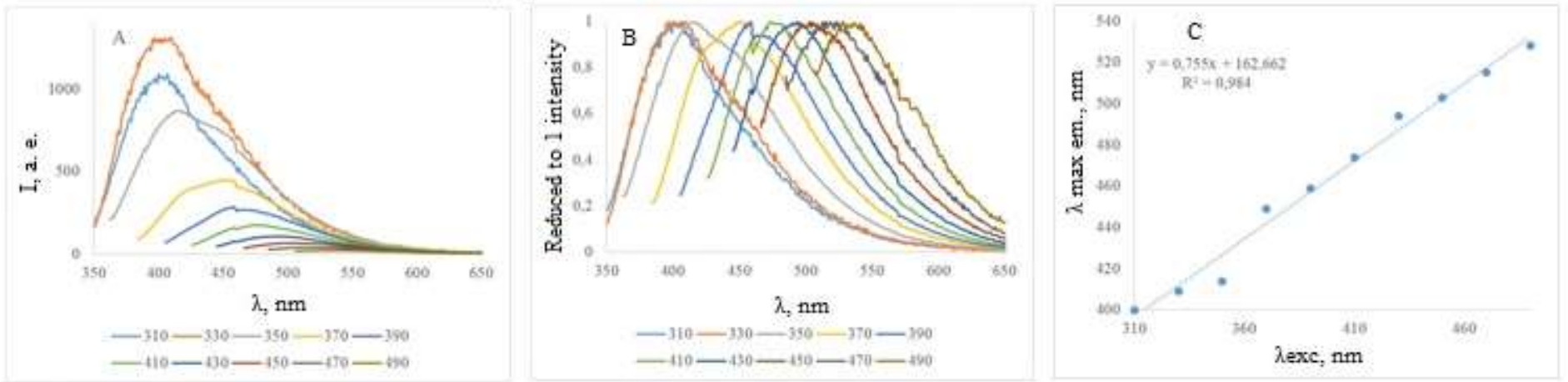
Results and Discussion

1. Hydrothermal treatment of L-aspartic acid

Synthesis time 2 hours



Synthesis time 3 hours



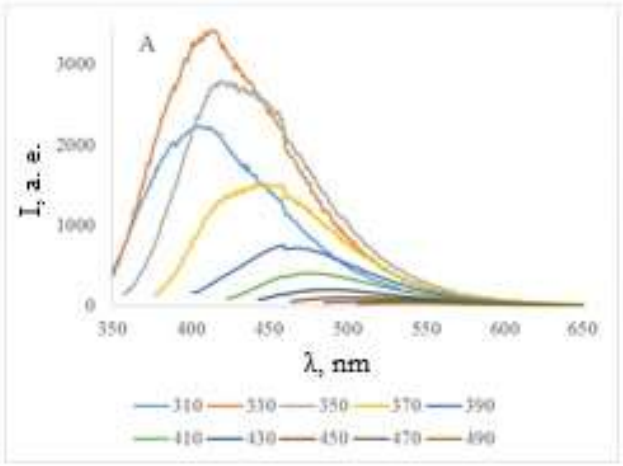
Emission spectra at different excitation wavelengths

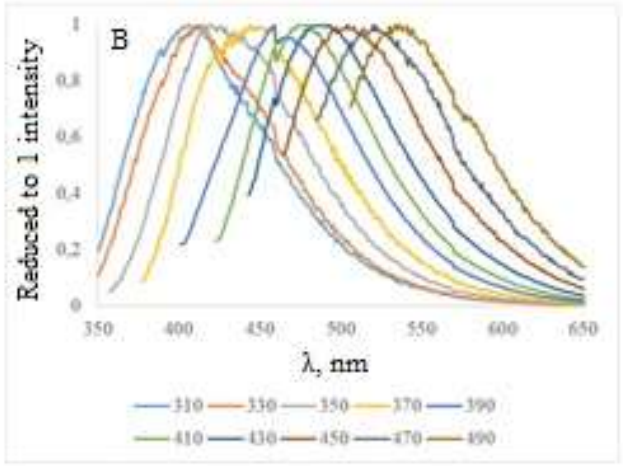
Normalized emission spectra at different excitation wavelengths

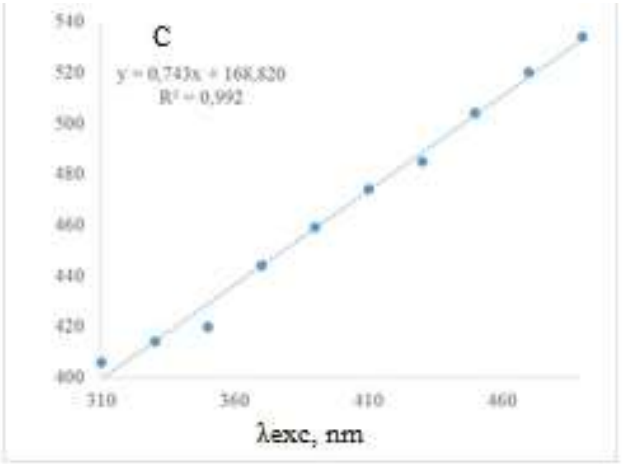
Dependence of the emission maximum wavelength on the excitation wavelength

2. Hydrothermal treatment of L-aspartic and citric acids

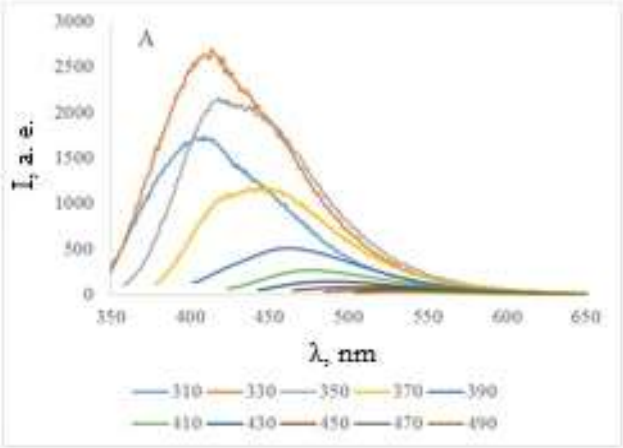
Synthesis time 2 hours

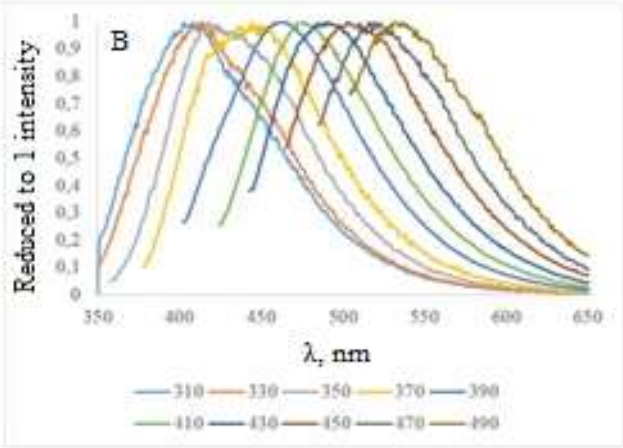


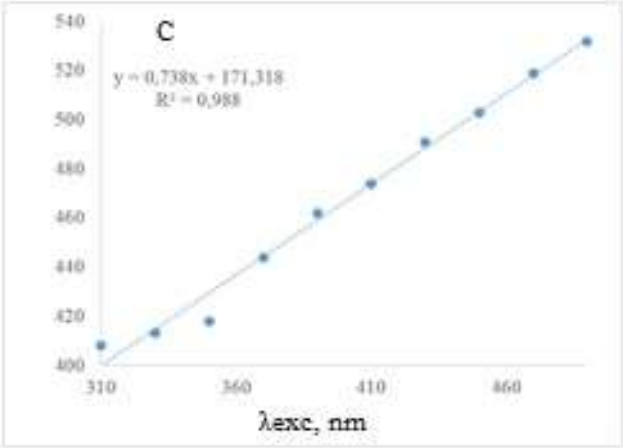




Synthesis time 3 hours







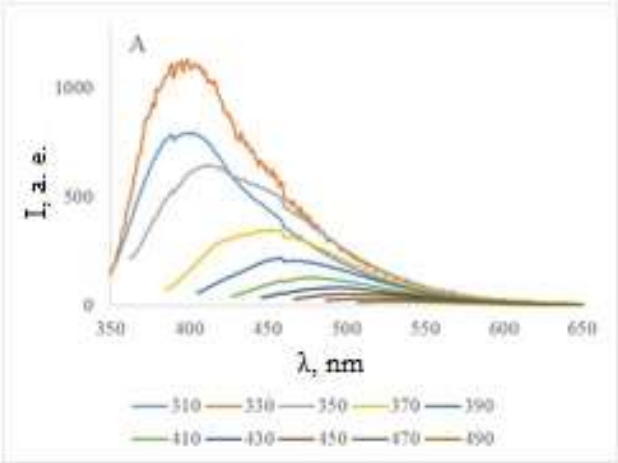
Emission spectra at different excitation wavelengths

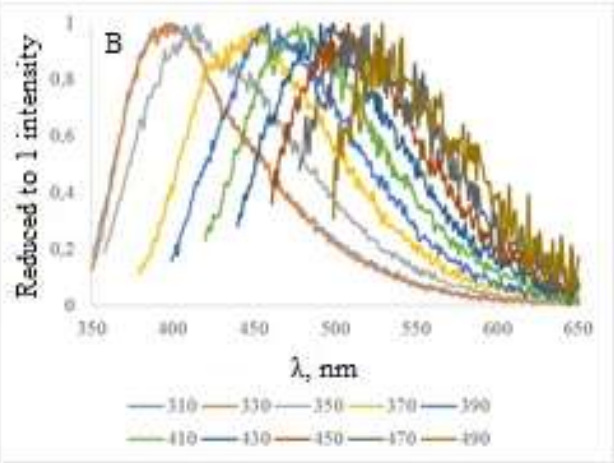
Normalized emission spectra at different excitation wavelengths

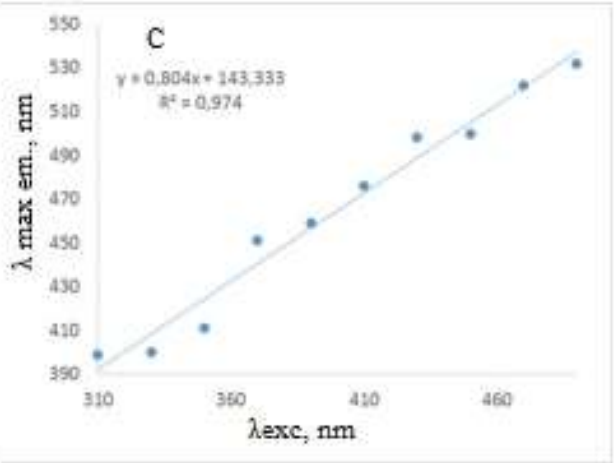
Dependence of the emission maximum wavelength on the excitation wavelength

3. Hydrothermal treatment of L-aspartic acid and 1,2-ethylenediamine

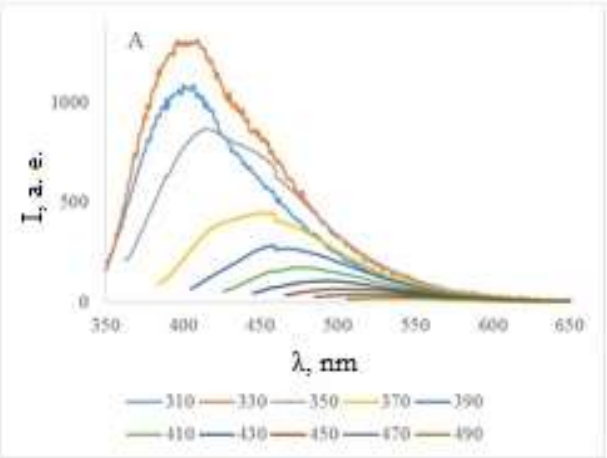
Synthesis time 2 hours



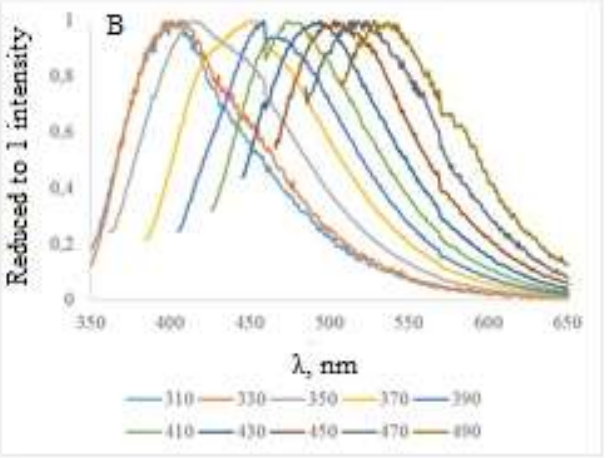




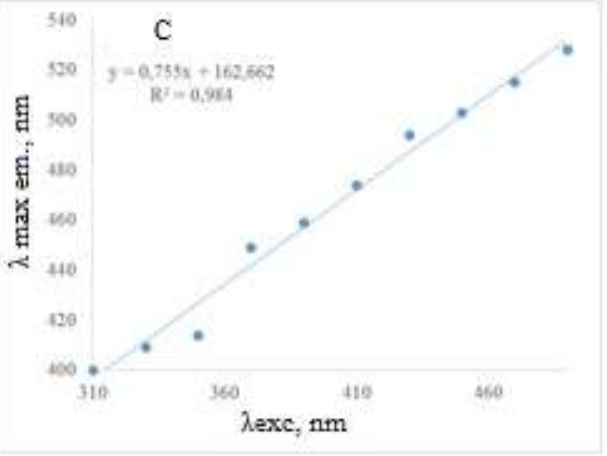
Synthesis time 3 hours



Emission spectra at different excitation wavelengths

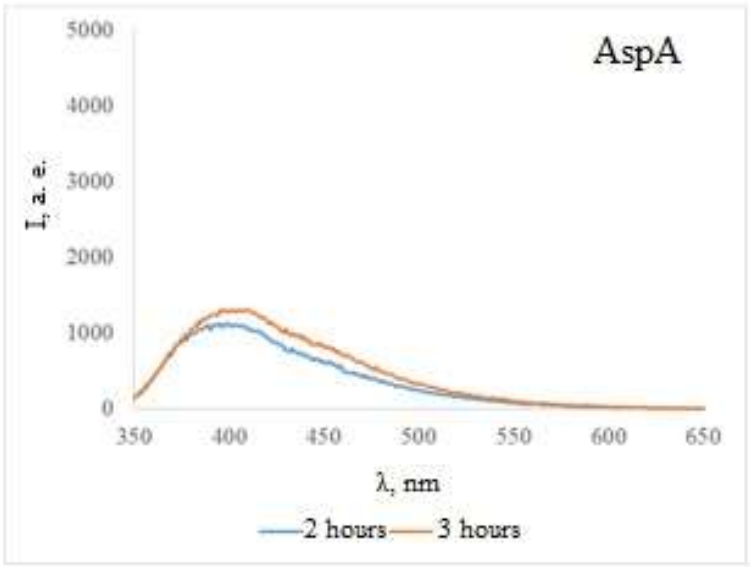


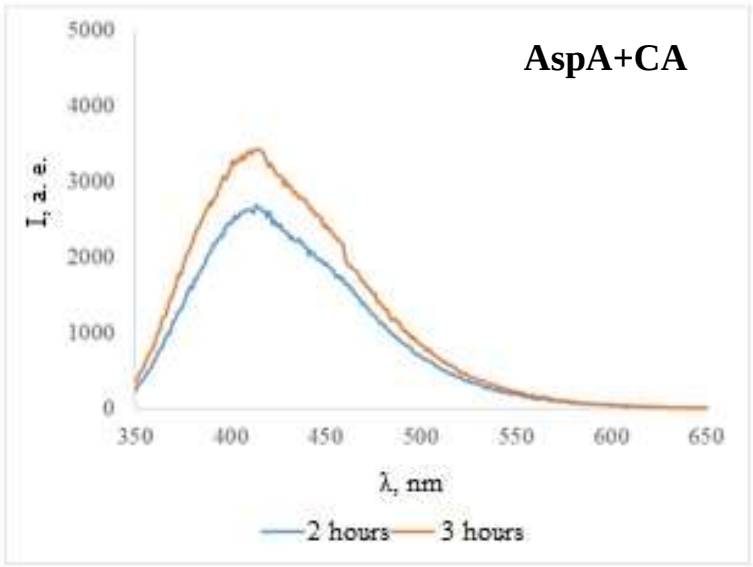
Normalized emission spectra at different excitation wavelengths

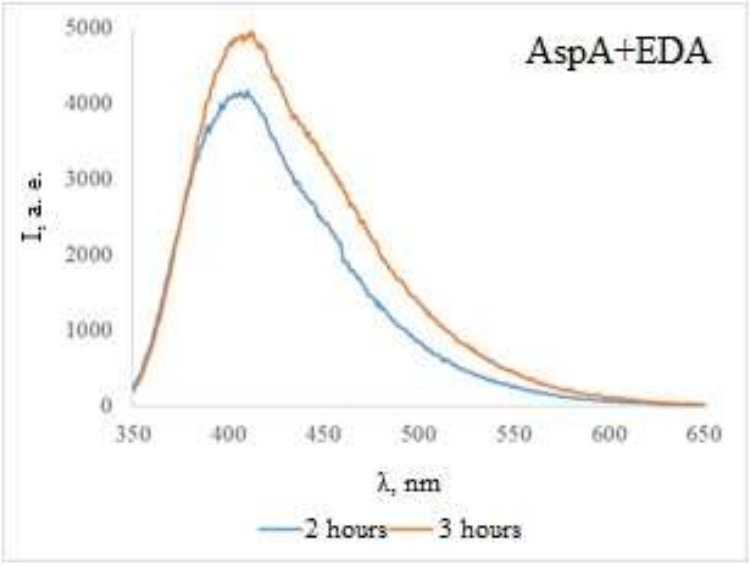


Dependence of the emission maximum wavelenght on the excitation wavelength

The effect of additives and the time of hydrothermal treatment on the emission spectra (λ_{ex} = 330 nm) of FNS







AspA AspA+CA AspA+EDA

The emission intensity of fluorescent products increases in the following order:
AspA > AspA+CA > AspA+EDA

With an increase in the duration of hydrothermal treatment, there is no significant increase in the fluorescence of the obtained structures.

Conclusion

1) FNS were obtained using hydrothermal treatment using individual L-aspartic acid and it equimolar mixtures with citric acid and 1,2-ethylenediamine. The fluorescence increases by 3-4 times for the mixtures comparing to the individual component. FNS based on L-aspartic acid and 1,2-ethylenediamine have the best fluorescent intensity;
2) The resulting structures have an emission maximum in the region of 400 nm and a pronounced linear dependence of the emission maximum on the wavelength of the exciting light (the correlation coefficients are ~ 0.97). According to the literature data, a similar dependence is typical for fluorescent structures based on carbon-containing materials;
3) An increase in the duration of hydrothermal treatment does not lead to a significant increase in the fluorescence of the obtained structures.

References

1) Xiangcheng S. Microwave-assisted ultrafast and facile synthesis of fluorescent carbon nanoparticles from single precursor: Preparation, characterization and its application for highly selective detection of explosive picric acid / S. Xiangcheng, H. Junkai, M. Yongtao, Z. Lichun, Z. Sichen, M. Xiaoyu, D. Swayandipta, Z. Jing, L. Yu // Journal of Materials Chemistry. - 2012. - V. 00, № 1-3. - P. 1-13.

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3) Казарян С. А. Синтез и исследование новых люминесцирующих углеродных частиц с высоким квантовым выходом эмиссии / С. А. Казарян, В. Н. Неволин, Н. Ф. Стародубцев // Перспектиные материалы. - 2018. - Т. 9. - С. 5-23.

4) Caoxing H. Synthesis of Carbon Quantum Dot Nanoparticles Derived from Byproducts in Bio-Refinery Process for Cell Imaging and In Vivo Bioimaging / H. Caoxing, D. Huiling, S. Yan, W. Yan, N. Robert, Y. Qiang // Nanomaterials. - 2019. - V. 9, № 387. - P. 1-11.

Thanks for attention!