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8CB-based plasmonic nanomaterials

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INTRODUCTION & AIM

Arranging plasmonic nanomaterials in a certain way can create materials with special optical properties, such as having anisotropy with refractive indices of simultaneously opposite signs for opposite light polarization [1]. This type of material can be based on doping a liquid crystal system with nanoparticles with the indicated properties.

Gold nanorods (AuNRs) are rod-shaped nanoparticles with size-dependent optical responses, and because of their plasmonic properties, they are used in imaging and fluorescent enhancement [2,3].

In our work, we synthesized various sizes of AuNRs and investigated its influence on the phase transitions of thermotropic liquid crystal 8CB.

GOLD NANORODS

Synthesis and size comparison:

The synthesis was performed following the procedure [3]. Four different aspect ratios (AR) were attempted to obtain by preparing a seed solution and proper growth solutions. Gold nanorods were measured using transmission electron microscopy and ImageJ software.

Table 1. Comparison of the sizes of the synthesized (actual) nanoparticles with the sizes obtained in the followed protocol.

Group	Reference AR	Actual AR	Reference Length [nm]	Actual Length [nm]	Reference Width [nm]	Actual Width [nm]
1	3.8	3.0 ± 08	21.7 ± 5.5	24.6 ± 5.5	5.8 ± 0.8	7.9 ± 1.9
2	5.6	3.6 ± 1.0	27.2 ± 4.4	25.1 ± 3.8	5.0 ± 0.5	7.3 ± 1.1
3	8.2	4.7 ± 1.1	48.4 ± 9.6	30.7 ± 4.9	6.0 ± 0.7	4.7 ± 1.1
4	10.8	6.3 ± 1.9	93.1 ± 18.3	48.1 ± 9.4	8.7 ± 1.0	6.3 ± 1.9

Among the synthesized nanoparticles, an increase in their length along with the increase in their aspect ratio is visible, but these values are smaller than those from the followed protocol. The first group of AuNRs has bimodal distribution of its average width, where in case of the other groups it is distributed monomodally.

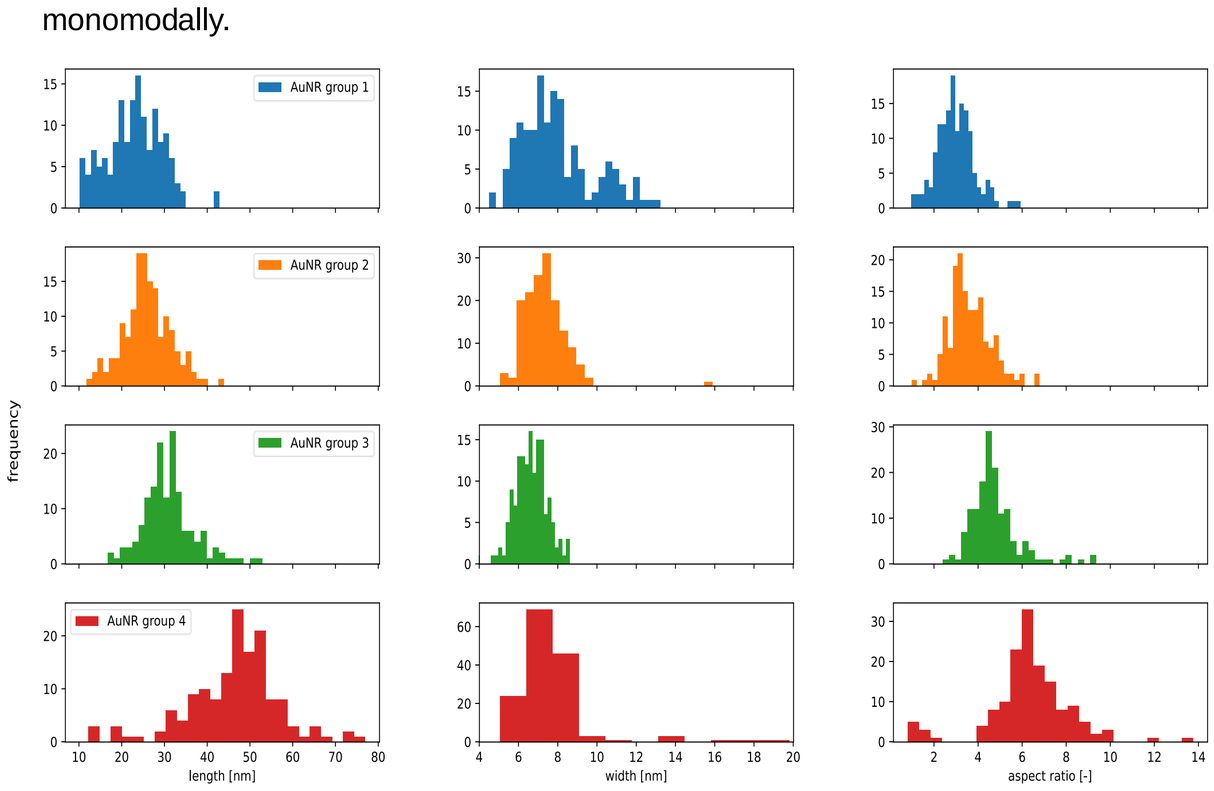

Figure 1. Histograms for each group of synthesized AuNRs.

Spectroscopic measurements:

A hypsochromic shift of 169 nm was observed when changing the solvent from water to toluene for nanoparticles with an assumend AR= 3.8.

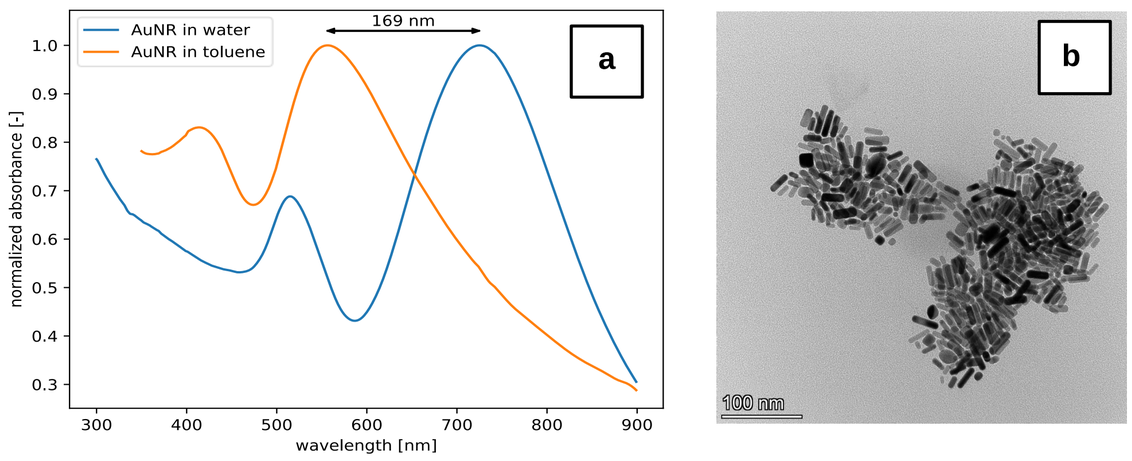

Figure 2. (a) Absorbance spectra for synthesized gold nanorods of actual aspect ratio 3.0 ± 0.8 suspended in water and toluene. (b) TEM image of AuNRs of AR= 3.0 ± 0.8.

8CB-BASED SYSTEMS

Synthesized nanoparticles ranging in size from 10 to 80 nm were transferred from water to chloroform and then added to 8CB in varying amounts to investigate the effect on changes in its structure and phase transition temperatures.

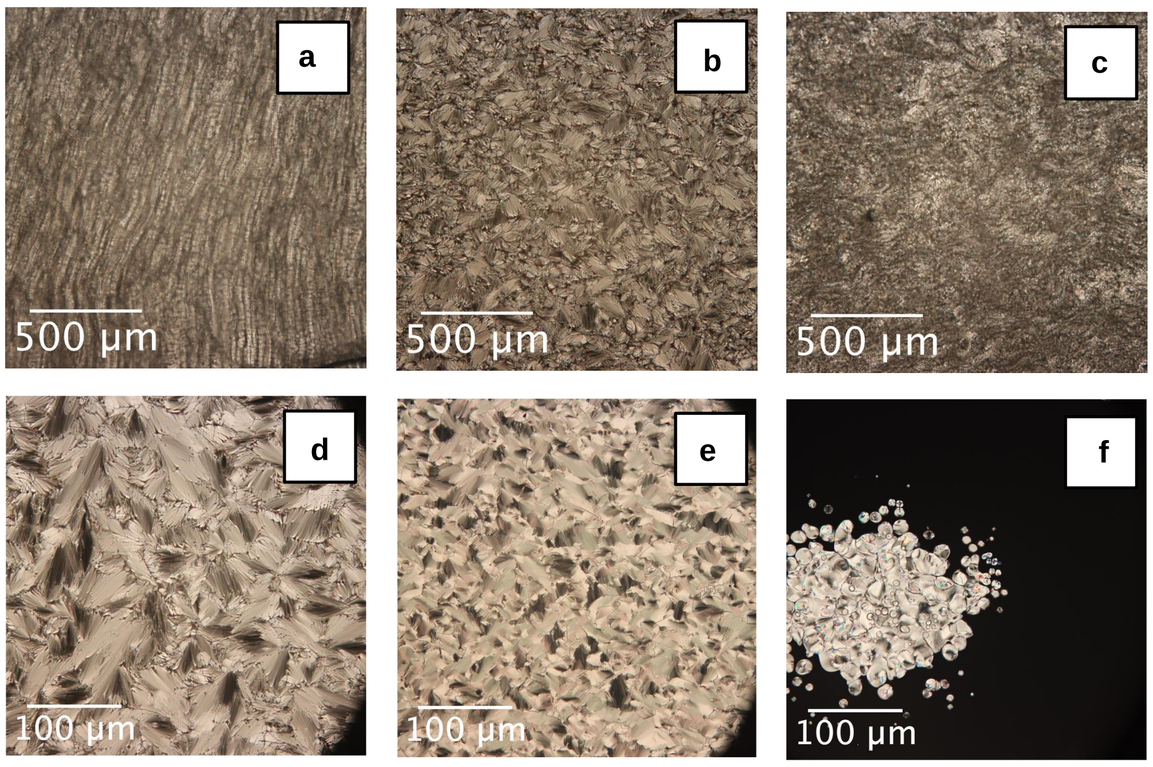

Figure 3. Polarized light microscope images of 8CB doped with (a) 1µ, (b) 10 µl, (c) 100 µl of AuNRs. Phase transitions of 8CB doped with 10 µl of AuNRs from (d) smectic to (e) nematic to (f) isotropic.

Table 2. Phase transitions of 8CB-based systems (where: Sm- smectic phase, N- nematic phase, I- Isotropic phase), heating and cooling 5°C/min.

		Phase transitions temperatures			
8CB mass [g]	AuNRs Volume [µl]	Sm-N [°C]	N-I [°C]	I-N [°C]	N-Sm [°C]
0,01923	0	31.4	37.8	39.9	32.2
0.01803	1	33.9	41.4	41.5	34.2
0.01824	10	33.8	41	41.1	33.7
0.01988	100	32.2	42.3	42	31.7

REFERENCES

[1] Huo Pengcheng, Zhang Si, Liang Yuzhang, Lu Yanqing, Xu Ting, *Hyperbolic Metamaterials and Metasurfaces: Fundamentals and Applications, Advanced Optical Materials* 7, 1801616 (2019)
[2] Abadeer Nardine S., Brennan Marshall R., Wilson William L., Murphy Catherine J., *Distance and Plasmon Wavelength Dependent Fluorescence of Molecules Bound to Silica-Coated Gold Nanorods*, *ACS Nano* 8, 8, 8392-8406 (2014)
[3] Chang Huei-Huei, Murphy Catherine J., *Mini Gold Nanorods with Tunable Plasmonic Peaks beyond 1000 nm, Chemistry of Materials* 30 (4), 1427-1435 (2018)