OPTICALLY ACTIVE HYBRID NANOSTRUCTURES BASED ON SEMICONDUCTOR QUANTUM DOTS AND CHIRAL MOLECULES FOR BIOMEDICINE
**OPTICAL ACTIVITY**
Circular dichroism (CD) spectroscopy

\[ g\text{-factor} = \frac{\Delta \varepsilon}{\varepsilon} \]

\[ \Delta \varepsilon = \varepsilon_L - \varepsilon_R; \quad \varepsilon = \varepsilon_L + \varepsilon_R \]
CHIRALITY IN BIOMEDICINE

Amino acids

Drugs

DNA

Enzymes
OUR CHIRAL WORLD…
…..AND CHIRAL NANOWORLD
SEMICONDUCTOR QUANTUM DOTS (QDs)

QDs properties:
- Size-dependent optical properties (quantum confinement effect)
- Narrow emission band
- High extinction coefficient in a broad spectral range
- High photoluminescence quantum yield
- High chemical stability and photostability
- Opportunity to surface modification

Sensors
Luminescent labels
Drug delivery & Energy donors
AIM OF RESEARCH

Investigation of optical properties of hybrid nanostructures (HyNSs) based on semiconductor QDs and chiral molecules

PRESENTATION OUTLINE
1. Optical properties of QDs in HyNSs
2. Optical properties of chiral molecule in HyNSs
3. Interactions of chiral HyNSs with surrounding environment

Tohgha U. et al. ACS Nano, 7(12), 11094-11102, 2013
1. OPTICAL PROPERTIES OF QDs IN HYNSS

CdSe/CdS QDs with different CdS shell thickness

<table>
<thead>
<tr>
<th>In nm</th>
<th>S0</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
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<tbody>
<tr>
<td>Diameter</td>
<td>2.8±0.4</td>
<td>3.7±0.4</td>
<td>4.1±0.4</td>
<td>4.5±0.5</td>
<td>4.9±0.6</td>
<td>5.2±0.8</td>
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<tr>
<td>Shell thickness</td>
<td>0</td>
<td>0.45</td>
<td>0.65</td>
<td>0.85</td>
<td>1.05</td>
<td>1.2</td>
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</tbody>
</table>
As-synthesized CdSe/CdS QDs were stabilized with achiral TOPO (trioctylphosphine oxide) molecules.
1. OPTICAL PROPERTIES OF QDs IN HYNSS

Phase transfer using chiral cysteine molecules

TOPO

L-Cysteine

D-Cysteine

Number of CdS Shells

PL QY, %

D-Cys

L-Cys

Graph showing PLQY as a function of the number of CdS shells.
1. OPTICAL PROPERTIES OF QDs IN HYNSs
SEMICONDUCTOR QD + ORGANIC MOLECULE

Ben-Moshe et.al. Nano letters, 16 (12), 7467-7473, 2016

2. OPTICAL PROPERTIES OF CHIRAL MOLECULE IN HYNSS

Chiral molecule
Chlorin e6 (Ce6)

Achiral QDs (CdSe)
2. OPTICAL PROPERTIES OF CHIRAL MOLECULE IN HYNSS

Achiral CdSe/CdS QDs

Achiral CdSe/CdS Dot-in-Rods
2. OPTICAL PROPERTIES OF CHIRAL MOLECULE IN HYNSS

QDs of different diameter

QDs of different shell thickness
2. OPTICAL PROPERTIES OF CHIRAL MOLECULE IN HYNSS
3. INTERACTION OF CHIRAL HYNSS WITH SURROUNDING ENVIRONMENT

Chiral sensing and separation

The three-point attachment model

3. INTERACTION OF CHIRAL HYNSs WITH SURROUNDING ENVIRONMENT

Bioimaging
CONCLUSIONS AND ONGOING RESEARCH

1. Influence of QDs shell thickness on QD photoluminescent and chiral properties

2. Influence of semiconductor QDs on optical activity of chiral molecule

Ongoing research

Investigate correlation between chiral and functional properties of hybrid nanostructures

3. Enantioselective interaction of chiral magnetic nanoparticles and chiral QDs

4. Enantioselective cytotoxicity of chiral QDs

ACS Nano, 11(9), 2017, 9207-9214

J. Mater. Chem. C, 2018, 6(7), 1759-1766

Chirality, 29(8), 2017, 403-408
Thank you for your attention!

Ms. Kuznetsova Vera
Dr. Purcell-Milton Finn
Prof. Orlova Anna
Prof. Fedorov Anatoly
Prof. Baranov Alexander
Prof. Gun’ko Yurii