Bachelor Thesis 2016

Radiosensitization using gold nanoparticles

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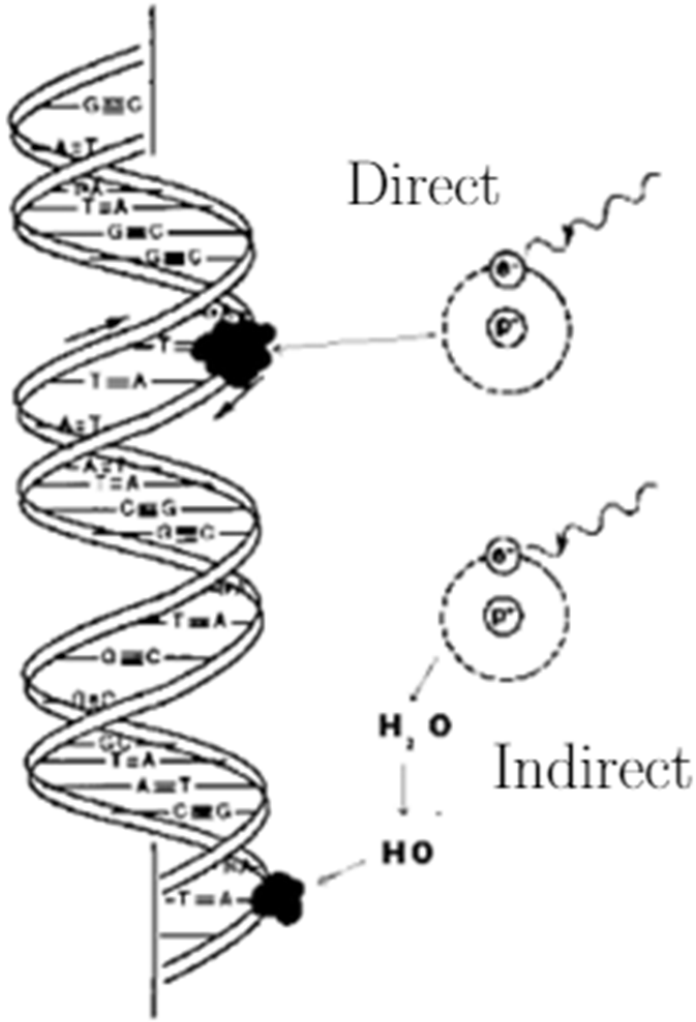
DNA damage using ionizing radiation

- Chemotherapy
- Surgery
- **Radiation therapy**

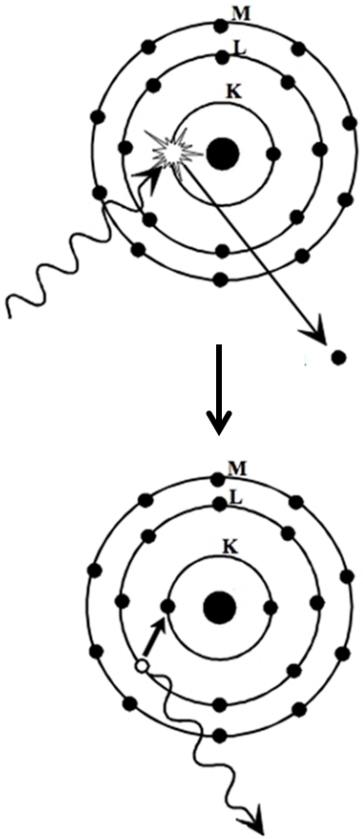
  Energy $\sim$ MeV



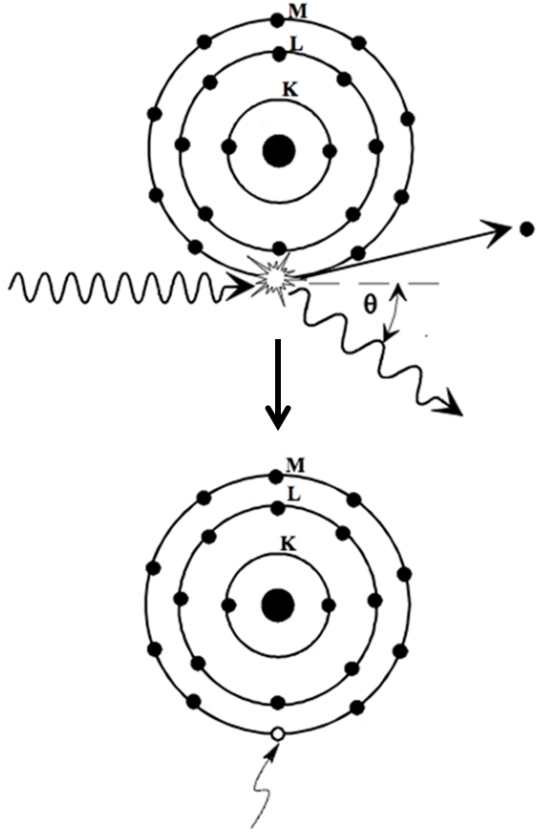
Source: https://chem.kuleuven.be/veiligheid/info/ioniserende-st.htm

Radiosensitization of cancer cells with gold nanoparticles (GNP) E ~ keV

Photoelectric absorption

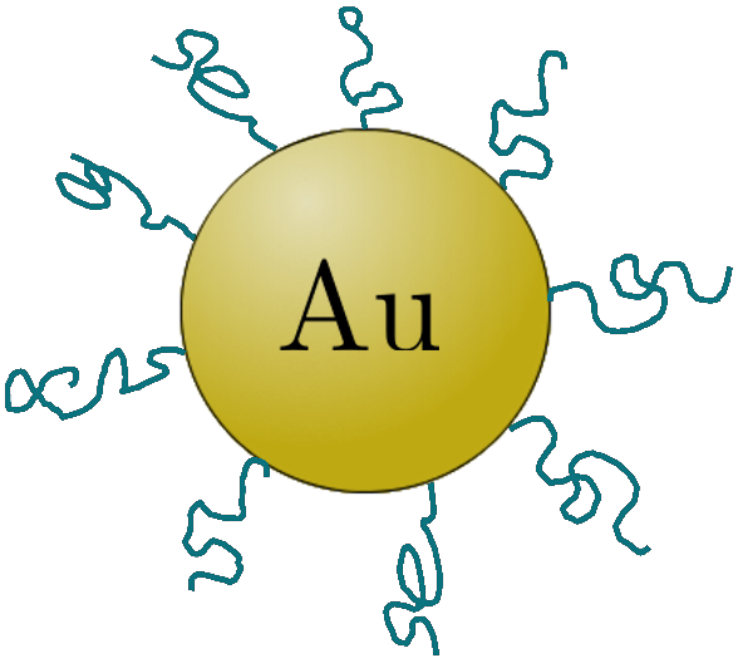


Compton effect

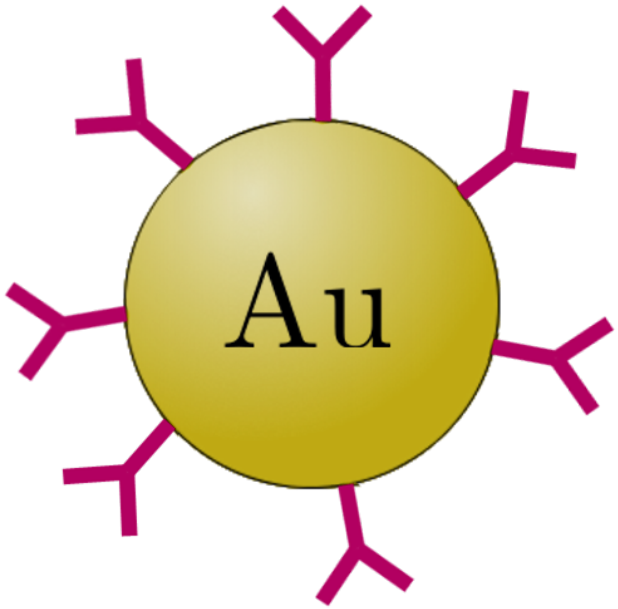


Targeting of the GNP to the tumor

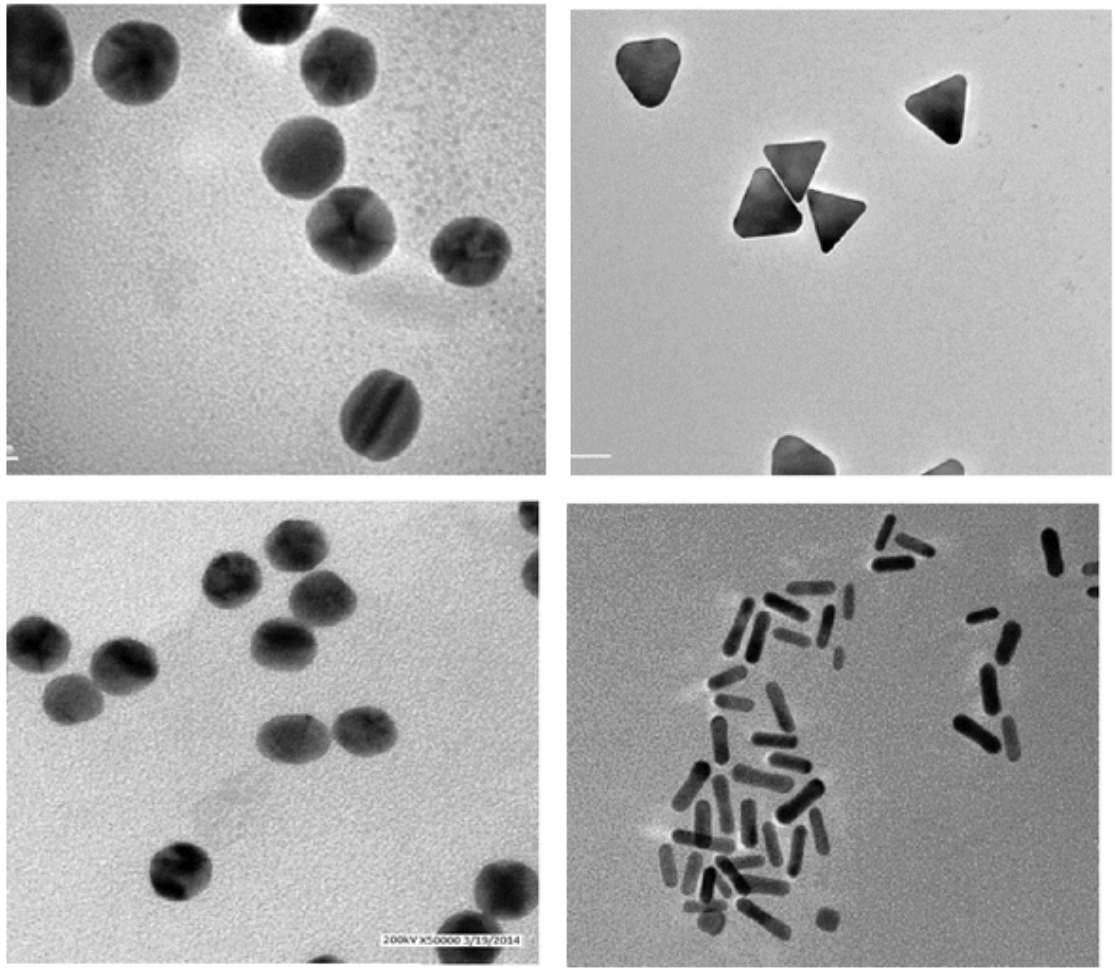
[c] **Passive targeting**
PEG coating



Active targeting
Antibodies

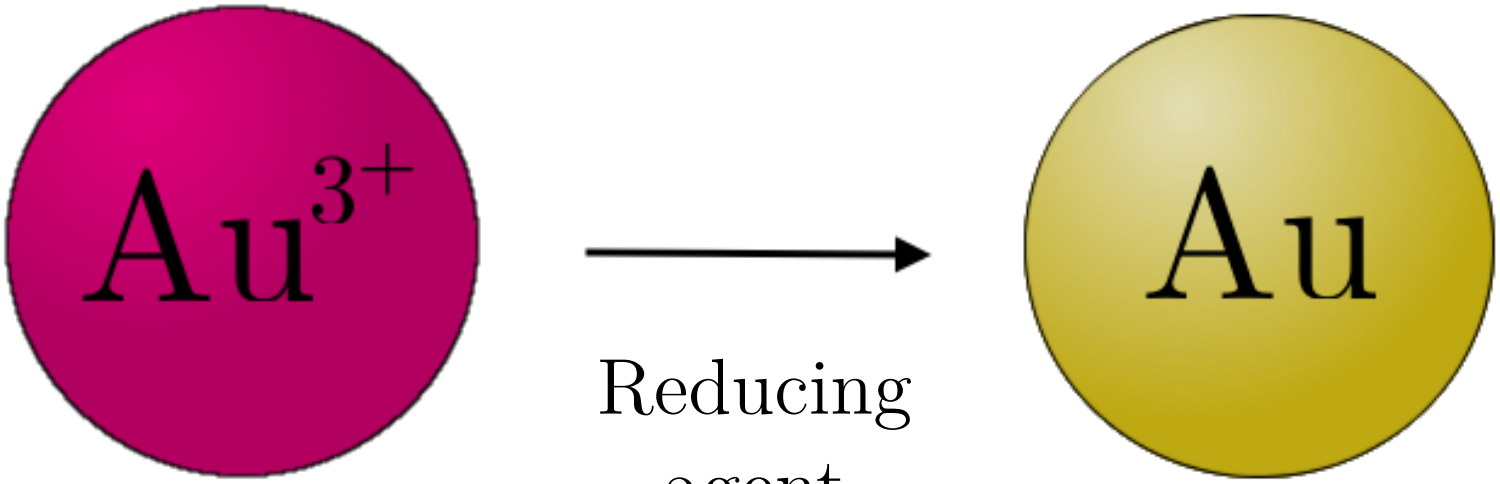


1. Synthesis
2. Characterization
3. Radiosensitization



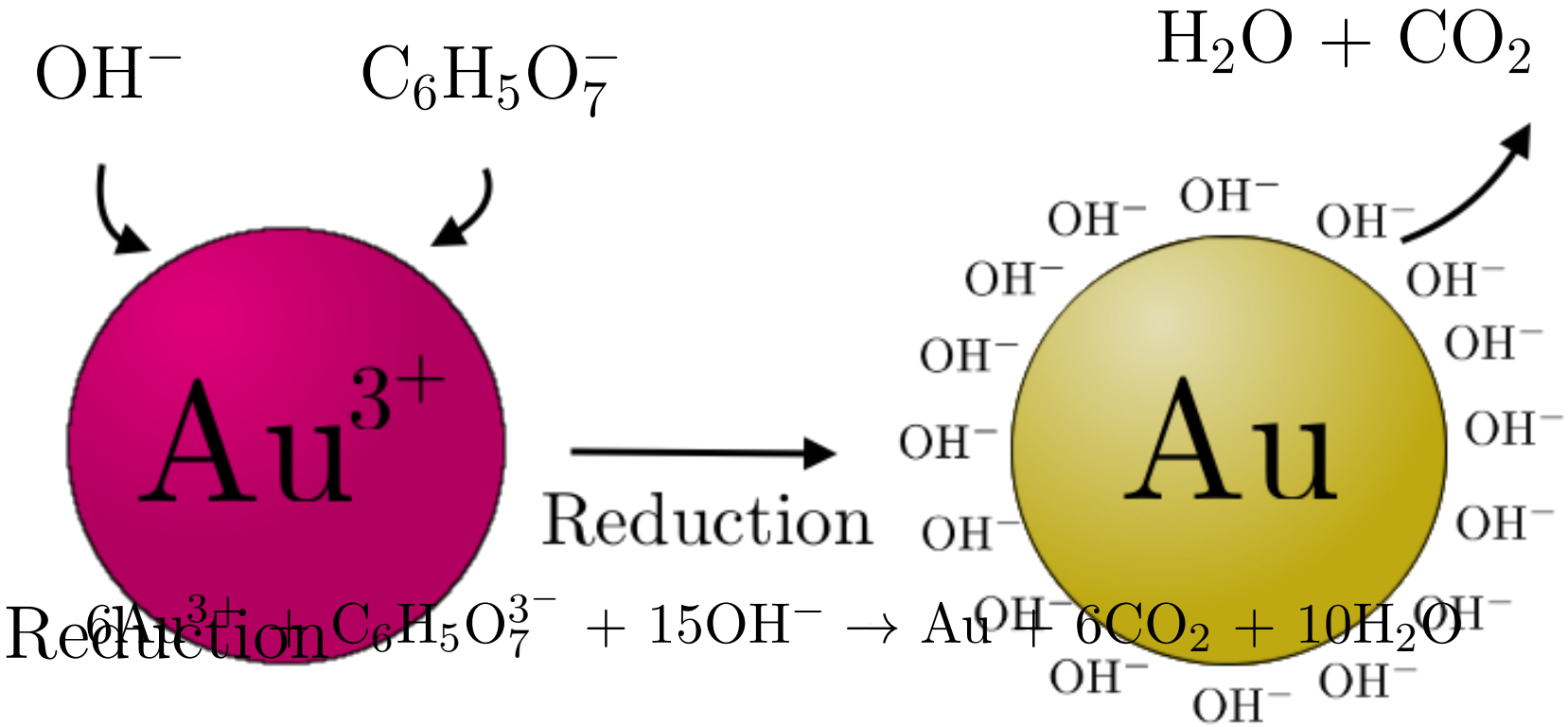
Source: A. Chaudhary , A. Gupta , S. Khan and C. Kanti Nandi *Phys. Chem. Chem. Phys.*, 2014 **16**

Reduction of gold ions to form GNP



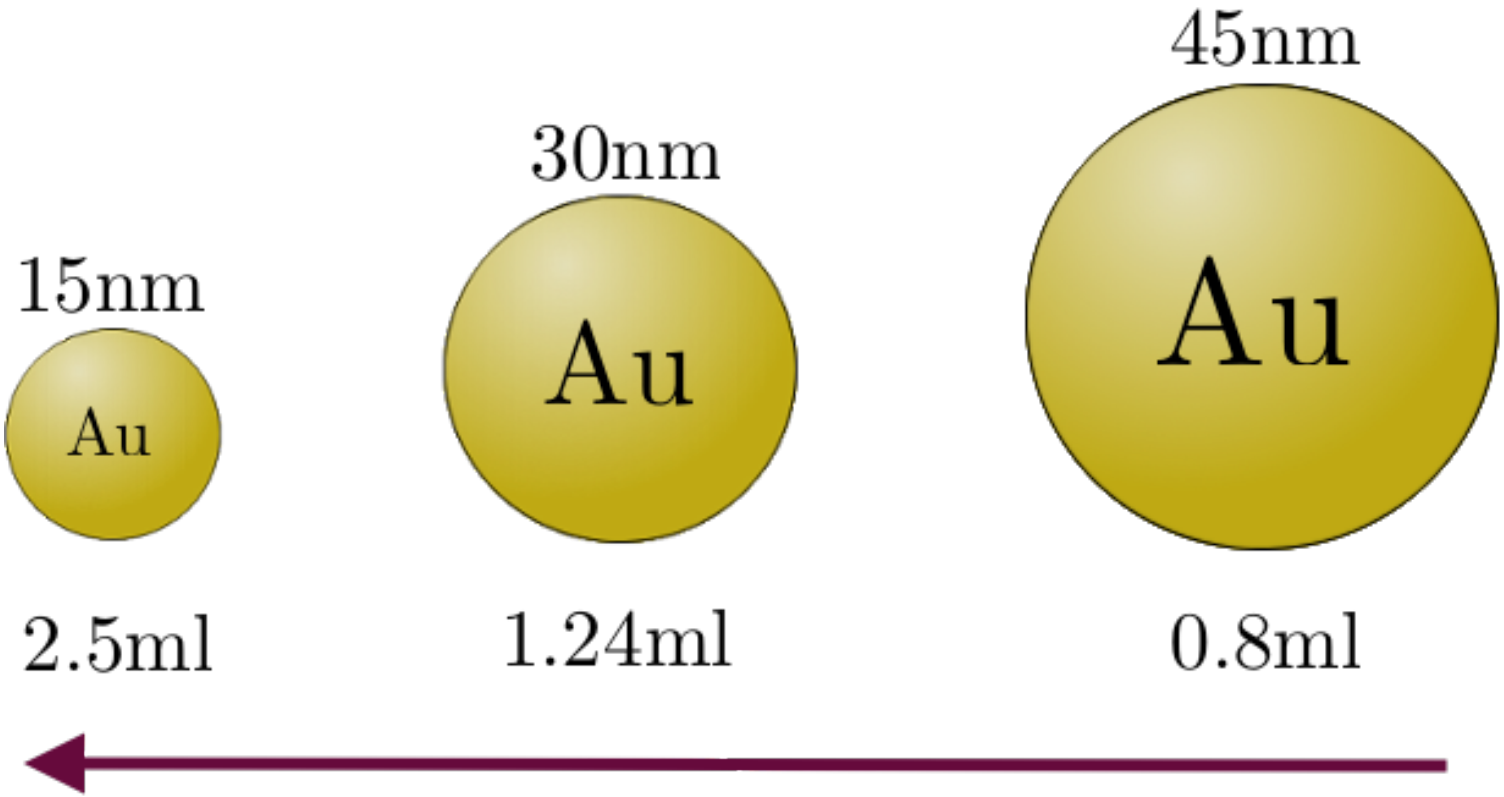
Gold ions: $HAuCl_4$ solution
Reducing agent: $Na_3C_6H_5O_7$

Reduction of gold ions to form GNP



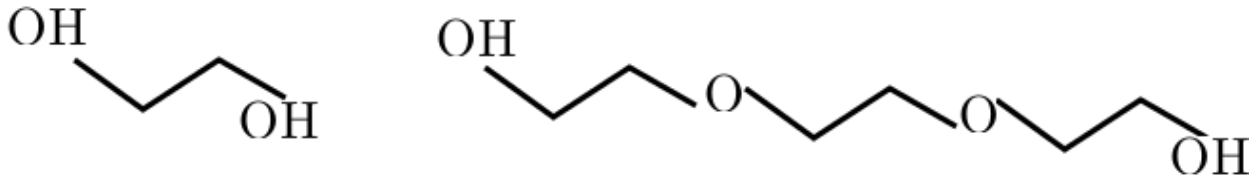
Reduction $6Au^{3+} + C_6H_5O_7^{3-} + 15OH^- \rightarrow Au + 6CO_2 + 10H_2O$

The amount of citrate controls the size

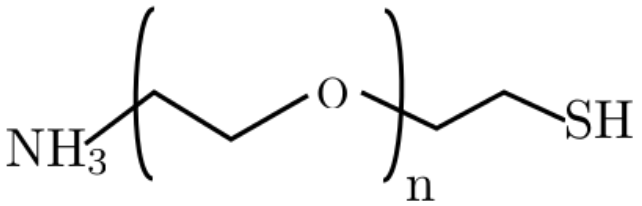


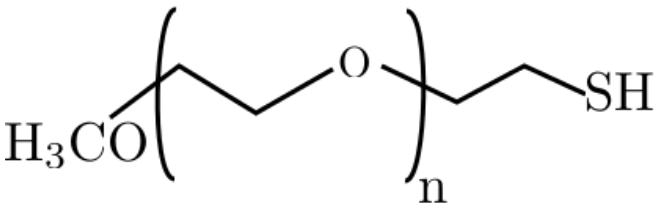
Citrate 1%
100ml $HAuCl_4$ 0.01%

PEG for targeting and stabilization

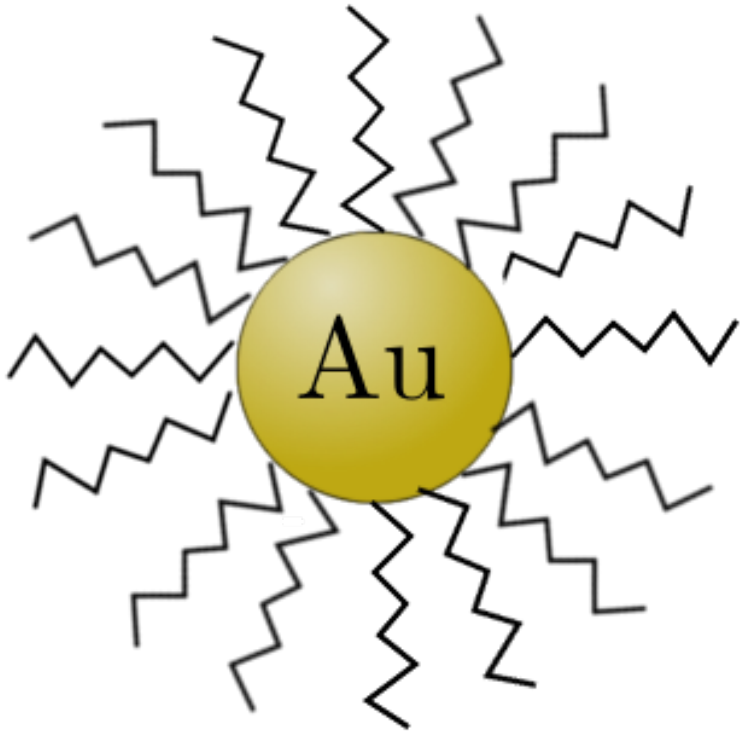


Ethylene glycol → Polyethylene glycol





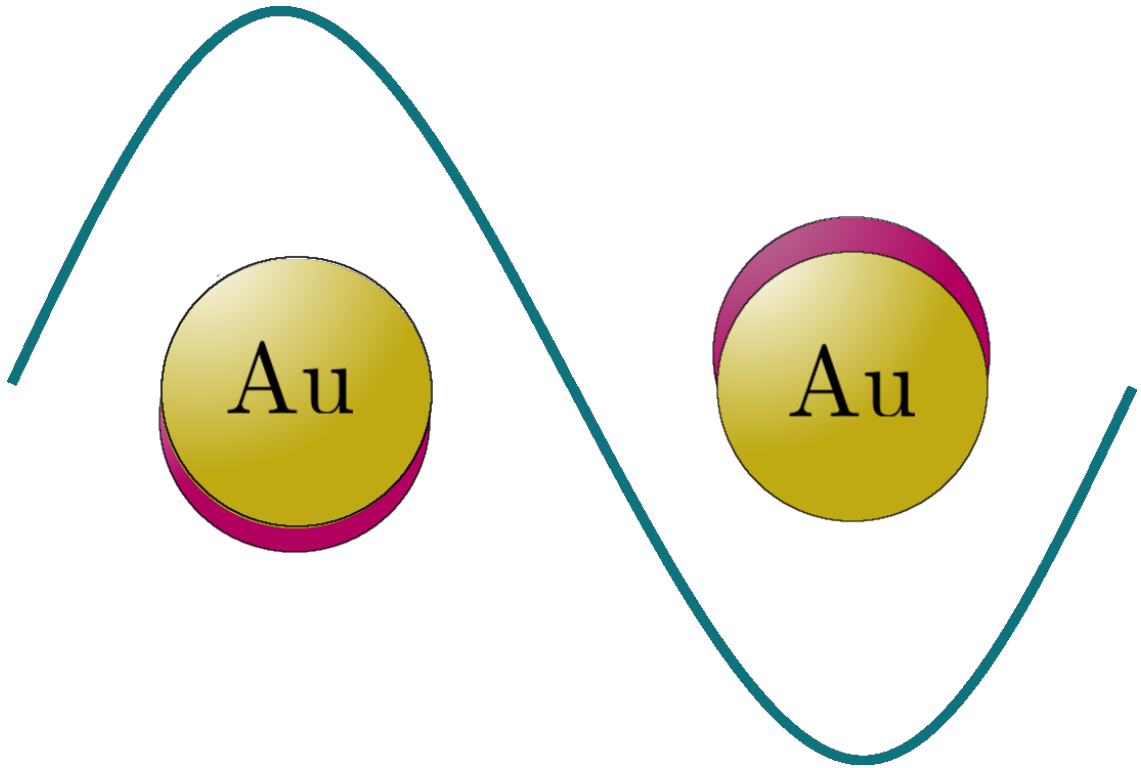
20k, 10k, 5k, 1k



TEM image analysis to determine core diameter

UV-Vis spectroscopy

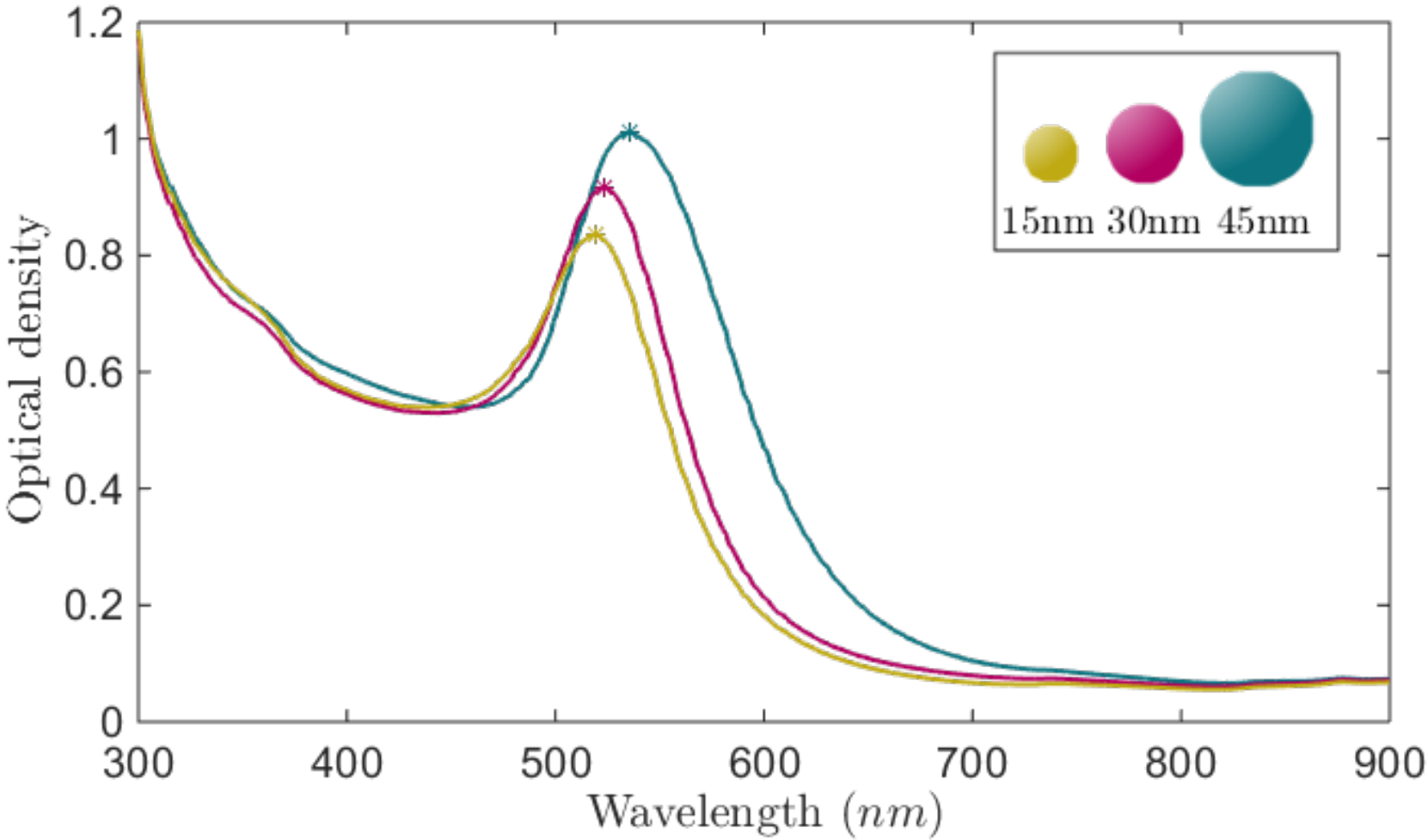
1. Add PEG
2. Size GNP
3. Add NaCl
4. Size GNP



bigger size → too little PEG
same size → enough PEG

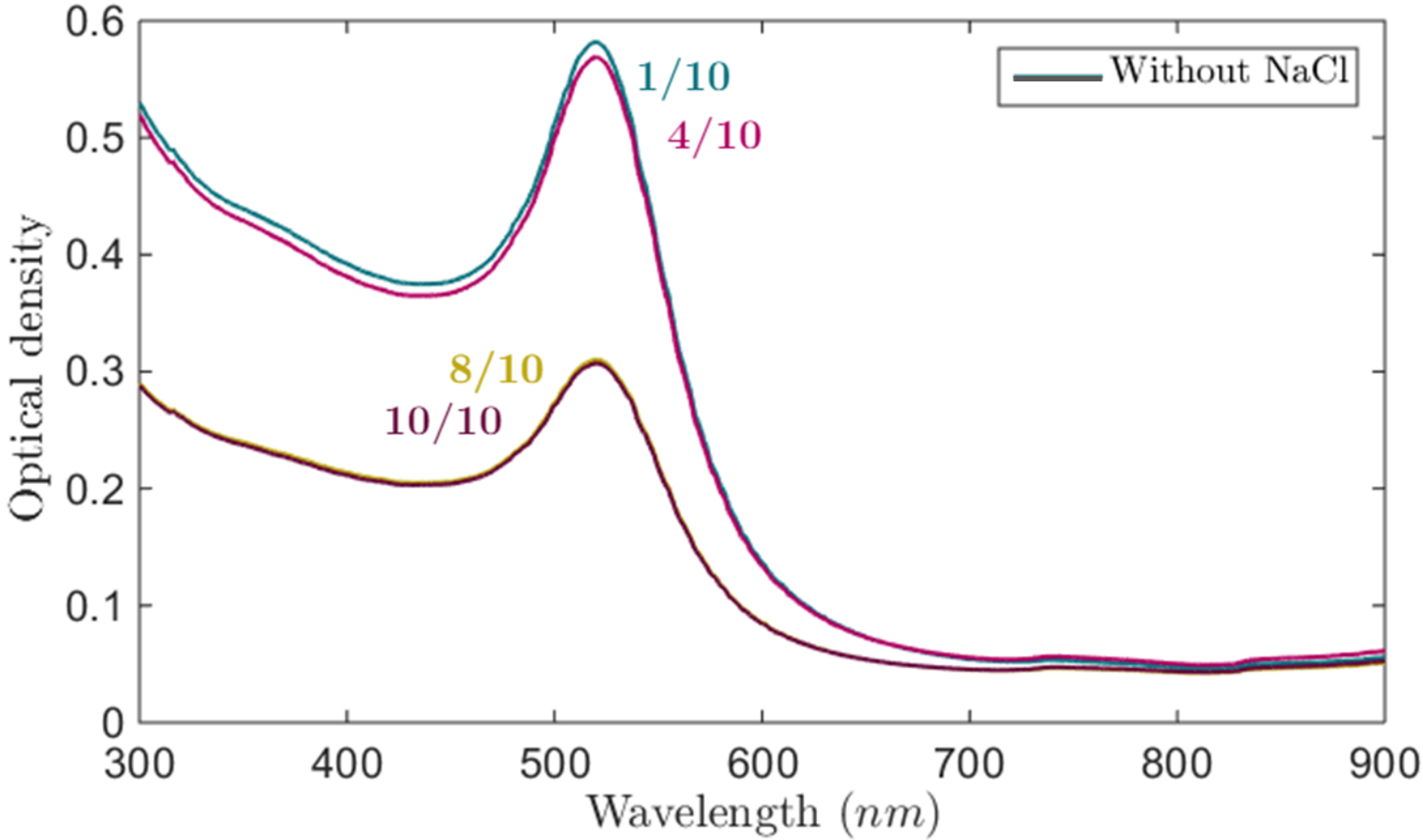
Results

GNP no PEG



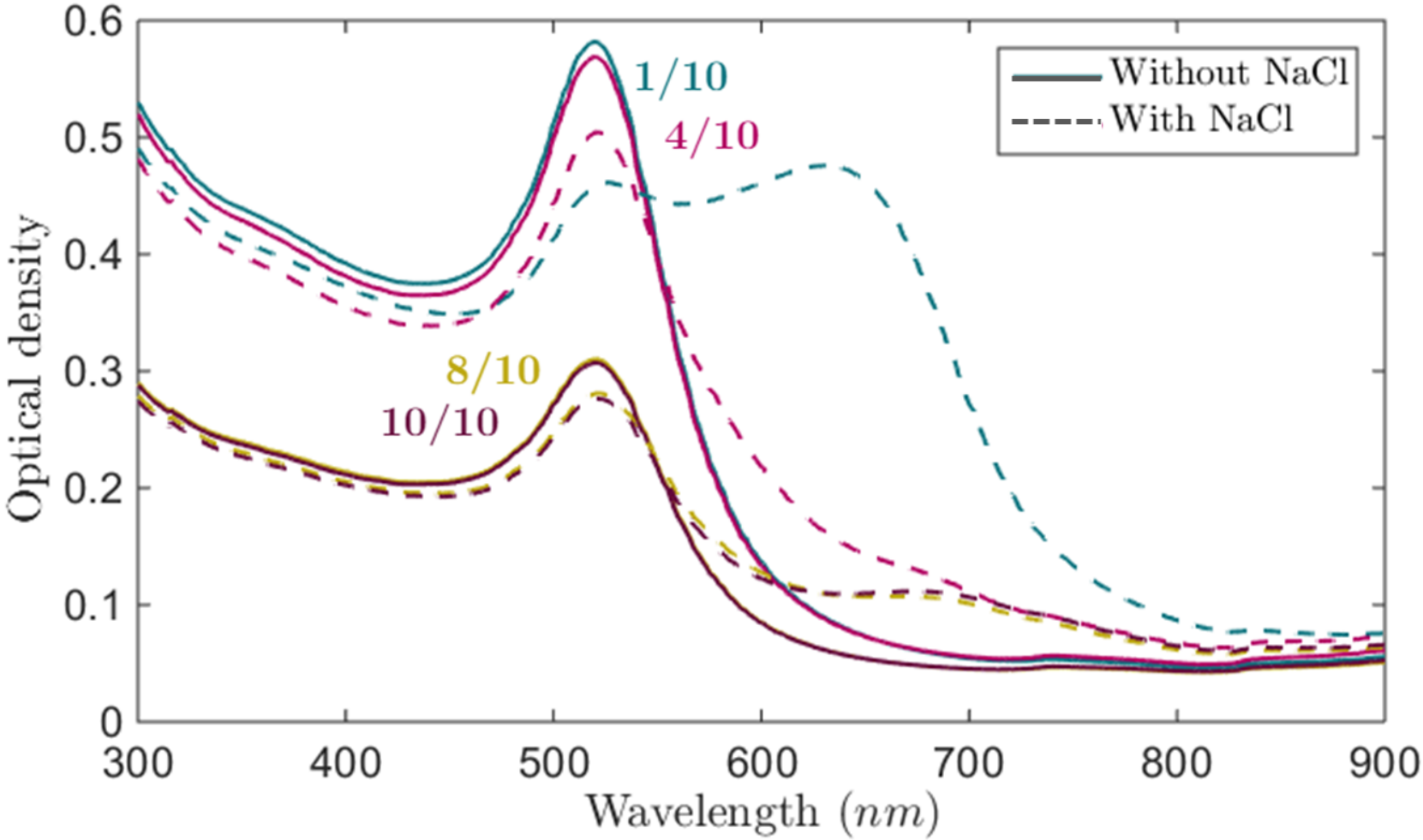
Results

15nm GNP 20k PEG for different PEG/GNP



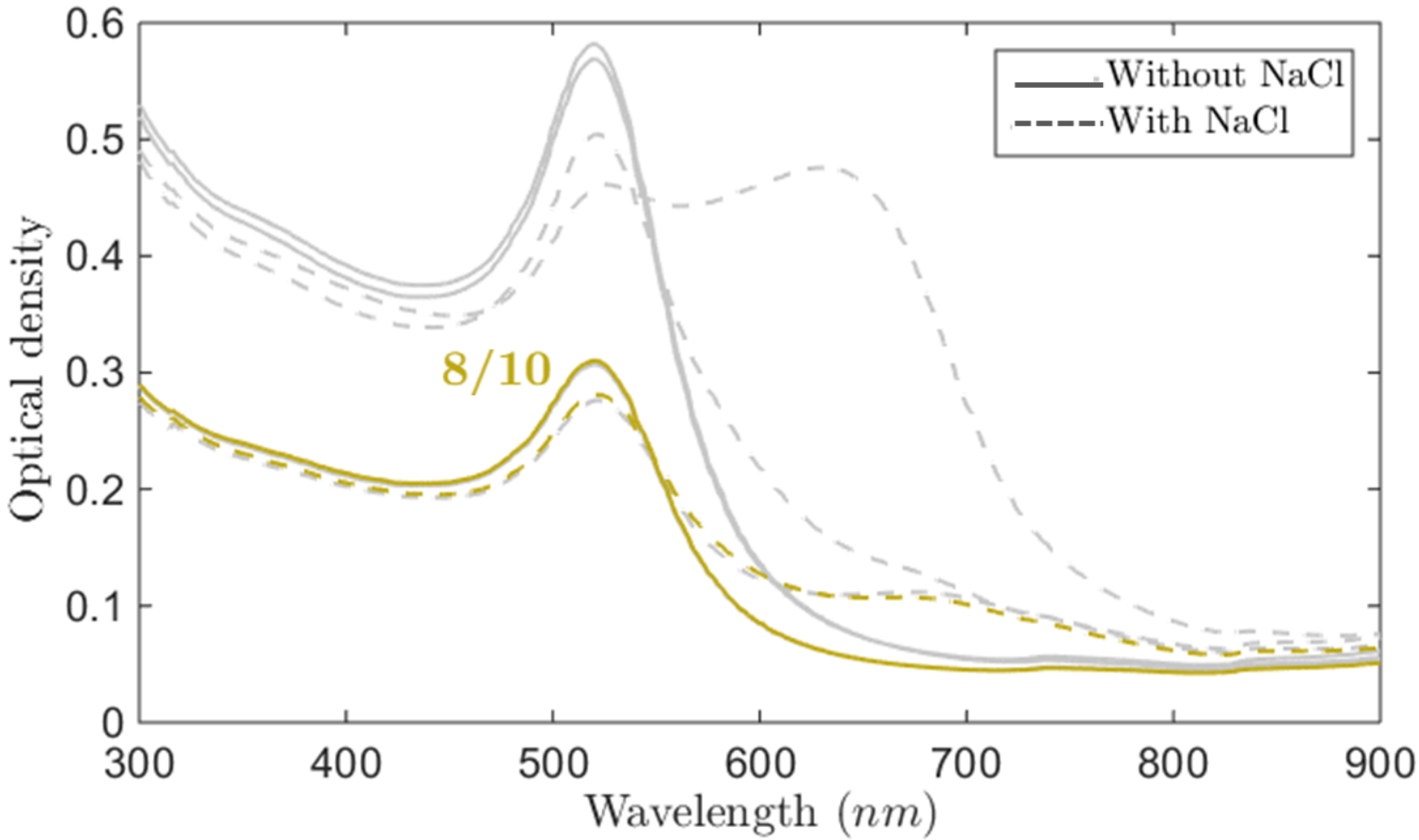
Results

15nm GNP 20k PEG for different PEG/GNP



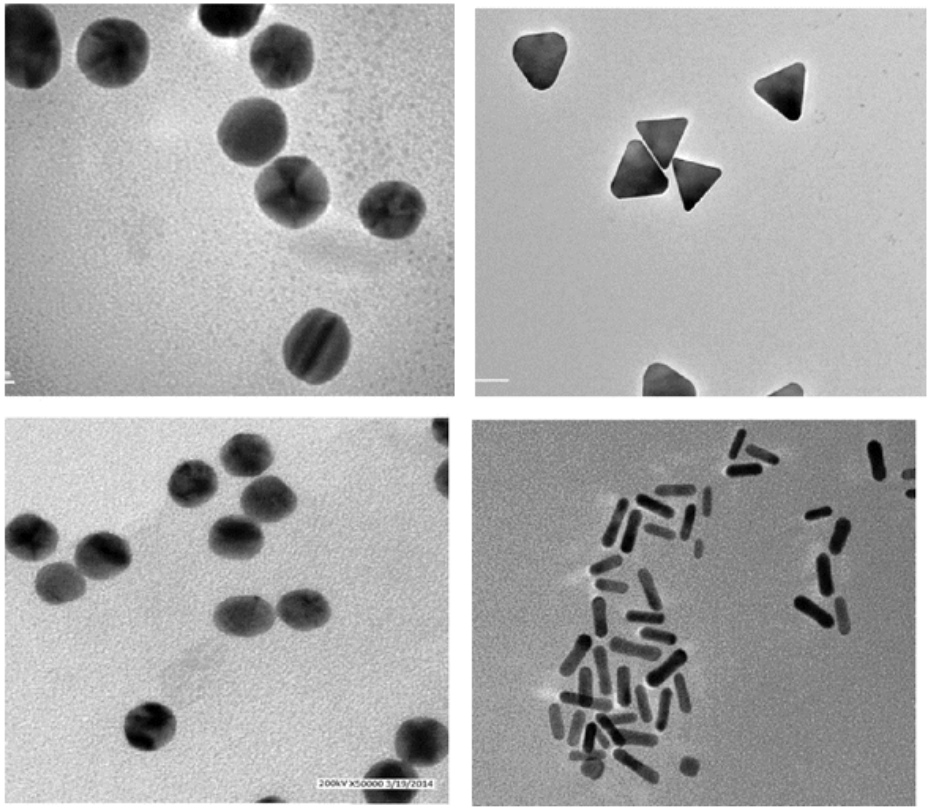
Results

15nm GNP 20k PEG for different PEG/GNP



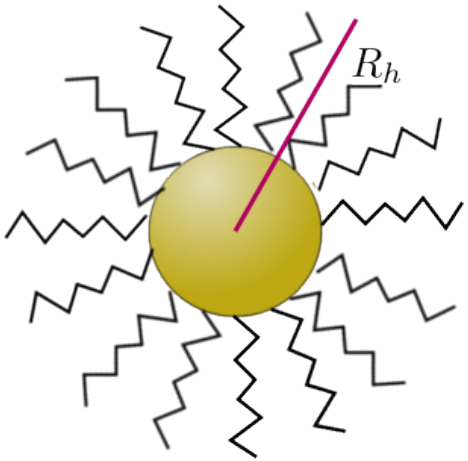
Overview

- Introduction
- Synthesis GNP
  - Chemical Protocol
  - Size GNP
- Stabilization
- Characterization
  - Size GNP
    - Chemical Protocol
    - UV-VIS
    - TEM
  - Hydrodynamic Radius
    - DLS



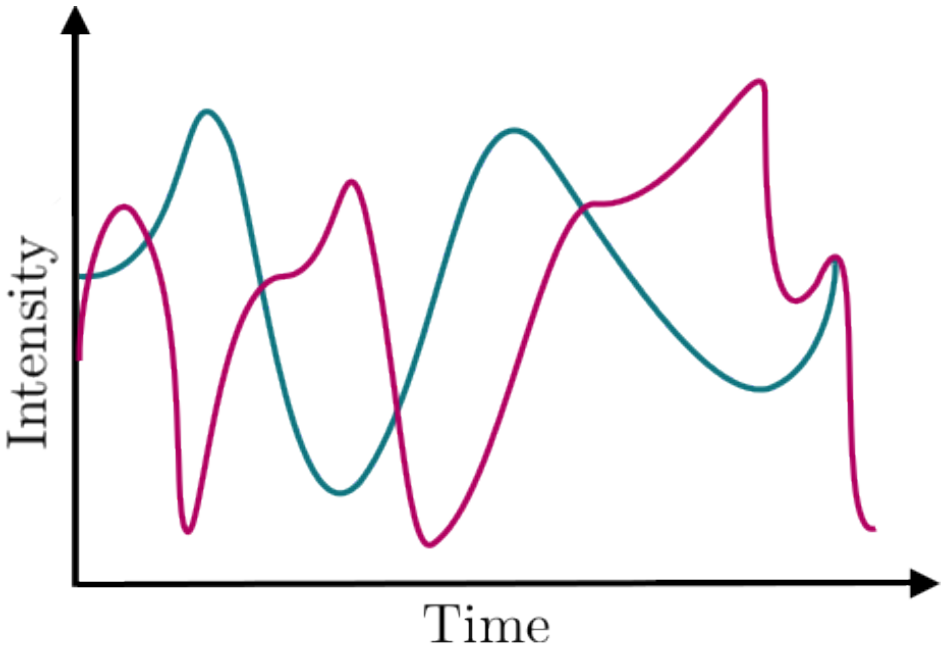
Source: A. Chaudhary , A. Gupta , S. Khan and C. Kanti Nandi *Phys. Chem. Chem. Phys.*, 2014 **16**

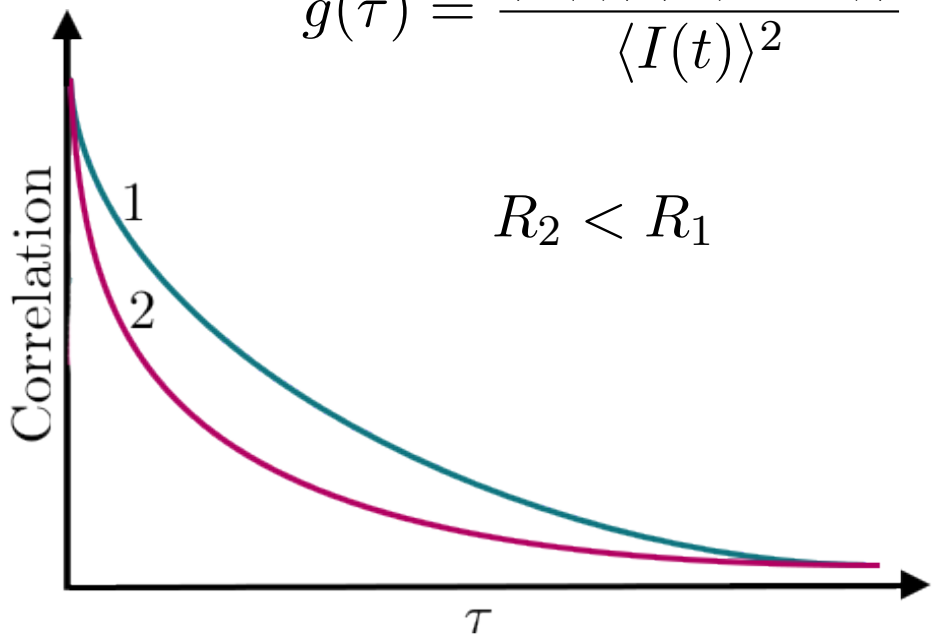
Dynamic light scattering (DLS)



Hydrodynamic radius (R_h)
$\rightarrow$ Rayleigh scattering

$$g(\tau) = \frac{\langle I(t)\rangle\langle I(t+\tau)\rangle}{\langle I(t)\rangle^2}$$

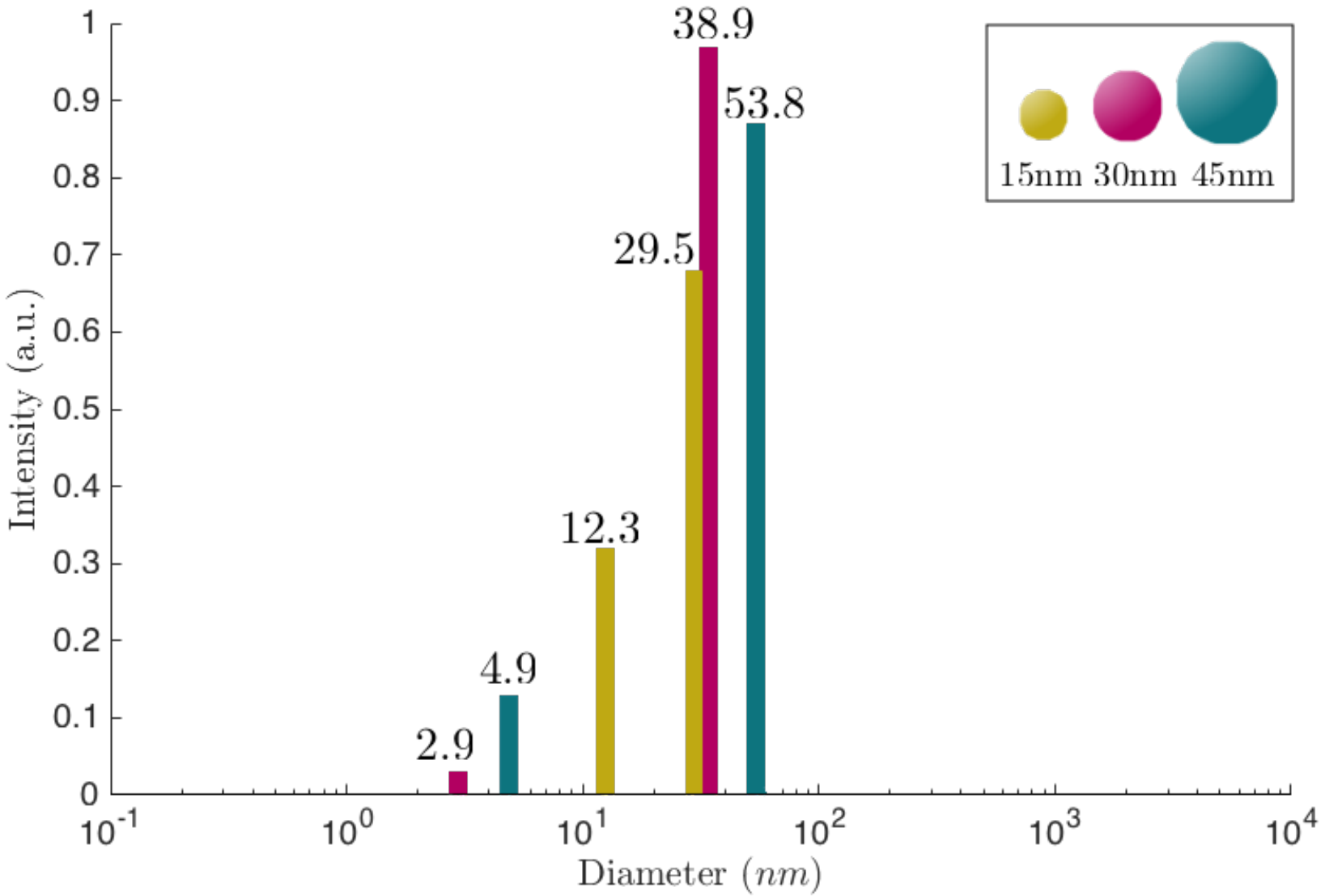




$R_2 < R_1$

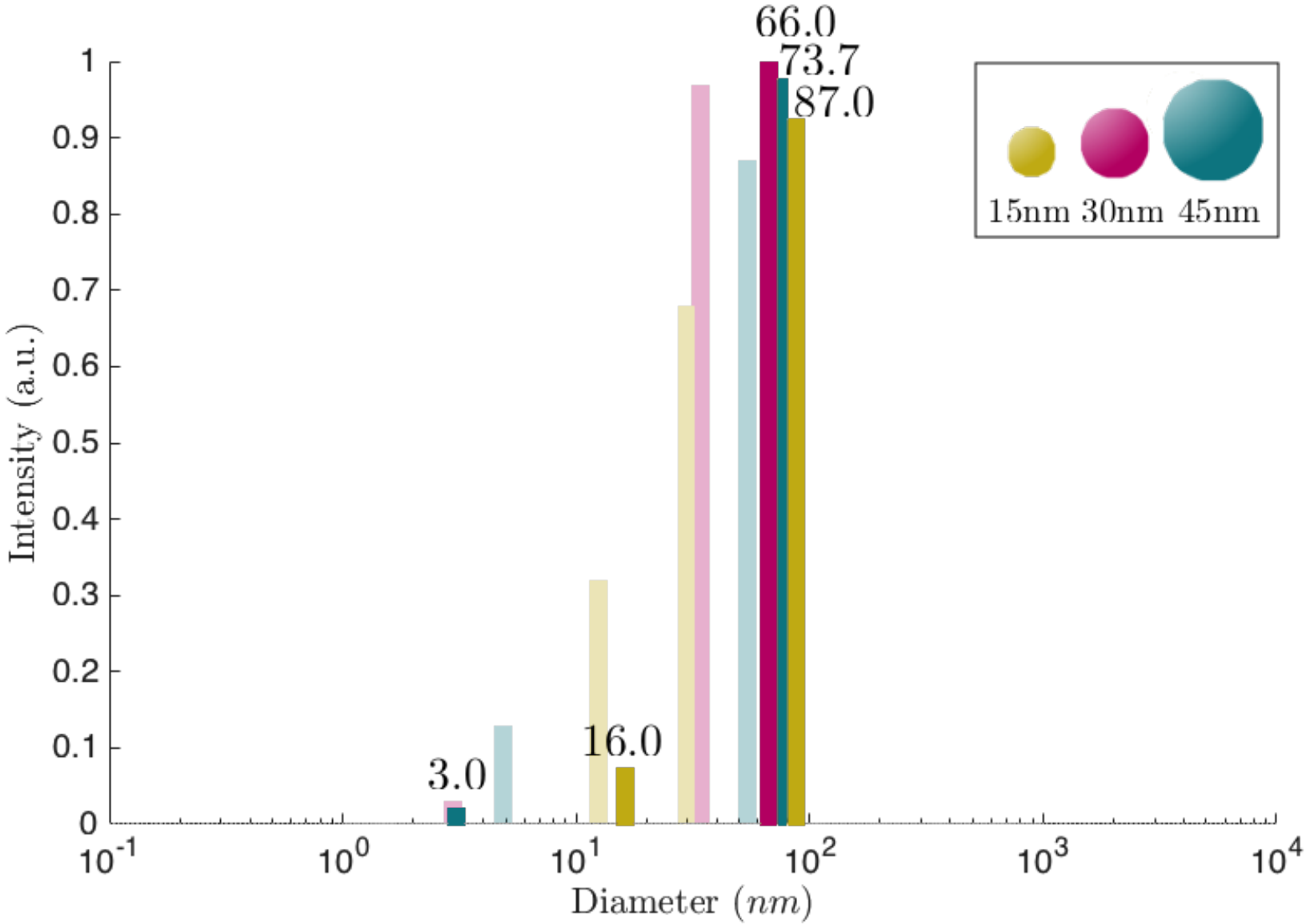
Results

Functionalisation no PEG



Results

Functionalisation 20k PEG

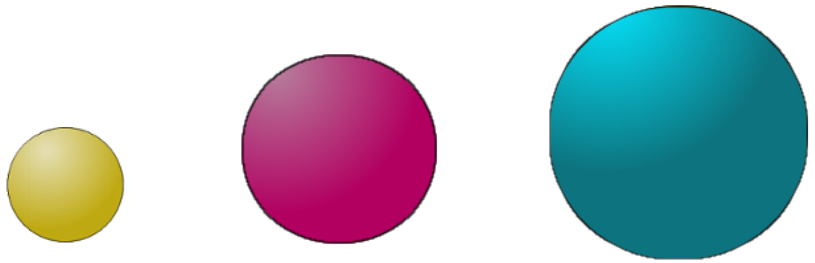


Results

Functionalization 15nm 20k PEG

Proportion (PEG/GNP)	**Average**
5/10	51.93 ± 2.76
6/10	80.89 ± 14.64
7/10	65.24 ± 14.32
8/10	83.91 ± 18.42
9/10	

Original functionalization 20k (8/10)



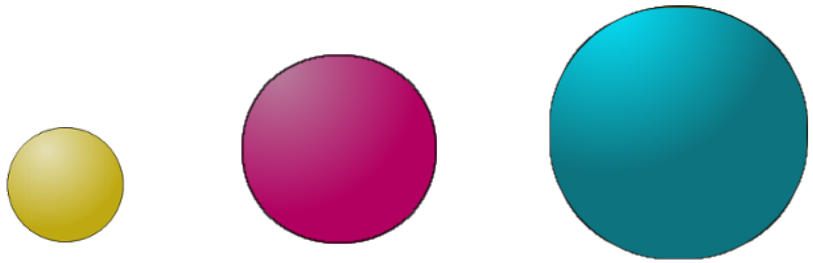
	15nm	30nm	45nm
PEG	87.0nm	66.0nm	73.7nm

Results

Functionalization 15nm 20k PEG

Proportion (PEG/GNP)	**Average**	**Average** (centrifuge)
5/10	51.93 ± 2.76	68.70 ± 7.99
6/10	80.89 ± 14.64	65.16 ± 11.61
7/10	65.24 ± 14.32	57.73 ± 7.72
8/10	83.91 ± 18.42	72.36 ± 10.44
9/10		56.54 ± 3.91

Original functionalization 20k (8/10)



	15nm	30nm	45nm
PEG	87.0nm	66.0nm	73.7nm

Conclusion

- Synthesis of GNP
- Characterization
- Stabilization with neutral PEG
- Stabilization with positively charged PEG
- X-Rays
- Analyze effect on DNA
- Solve problem with DLS