

Bachelor Project

Semester II:

Gold Nanoparticles:

- * synthesis
- * characterisation
- * radiosensitization of DNA
with GNP

Mannelore: 2030 Lier: 50 Week: 15/02 - 21/02

Summary: first acquaintance +
literature study

Assistants:

- * Mattias Vervaele \Rightarrow 2000 05.23
Mattias.vervaele@fys.kuleuven.be
Vaste-stoffysica en Magnetisme
- * Bert De Roo \Rightarrow 2000 02.64
bert.deroo@fys.kuleuven.be
Vaste-stoffysica en Magnetisme
- * Stephanie Sere \Rightarrow 2000 05.23
stephanie.sere@fys.kuleuven.be
Vaste-stoffysica en Magnetisme

Goal:

- 1) Make/synthesize GNP
 - 2) characterize them with the different techniques
 - 3) check/analyze the positive radiosensitization effect of GNP on DNA
- \Rightarrow Very analogue to the masterthesis of
Lennert Wouters
- \rightarrow we perform an extra test
 - \rightarrow extra data.

Summary: first acquaintance with the lab + synthesis GNP

- * guided tour around the lab
- * Synthesis GNP \rightarrow protocol from Jannaert Wouters
 1. A solution of 100 ml 0.01% HAuCl_4
 2. boiling Temperature & stirring
 3. Three options:
 - 15nm \leftarrow 2.5 ml
 - 30nm \leftarrow 1.24 ml
 - 45nm \leftarrow 0.8 ml
- 4. boiling + stirring for 35 min.
- 5. cooling down + protecting from light for 60 min
- 6. Storing; 4°C + no light

Calculation:

$\frac{\%}{\%} \rightarrow \frac{m}{m} \rightarrow$ we look $\frac{V}{V}$

\hookrightarrow No GNP since wrong calculation
(To little HAuCl_4)

* first acquaintance with
characterization techniques

* \leadsto Overview

* try out with DLS (Dynamic light
scattering.)

Overview thesis

- ① Make GNP \rightarrow protocol Lennart
+ functionalize (PEG) Wouters
- ② Characterize GNP \rightarrow which one shall we use?
 $\text{NH}_2 \leftarrow$ neutral / charged
 OCH_3
 - a. UV-Vis \rightarrow core diameter
 - b. DLS \rightarrow hydrodynamic radius
 - c. ζ -pot. \rightarrow stability colloid
 - d. TEM \rightarrow image + more exact core
diameter
 - e. TGA \rightarrow weight percentage difference
+ PEG capping density P_c
- ③ Mix with DNA and irradiate
- ④ Gel electrophoresis to study the
radiosensitization effect.

Characterization Techniques

① UV-Vis (Ultraviolet-visible spectroscopy)

⇒ core diameter

* UV-radiation through sample

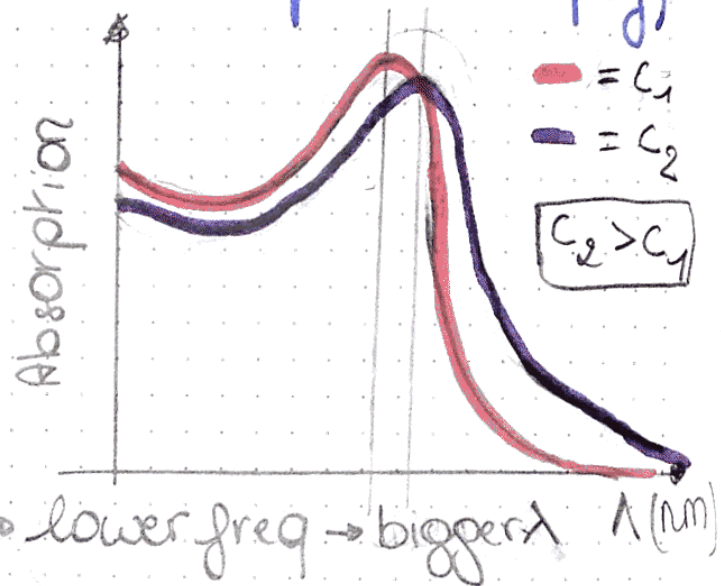
* surface plasmons

→ resonant freq.

↳ depends on the size of NP



bigger → lower force → lower freq → bigger λ



② DLS (dynamic light scattering)

⇒ hydrodynamic radius

* infrared radiation through sample

* Rayleigh scattering

* measure I

↳ variance due to brownian motion of NP

* Determine auto-correlation

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

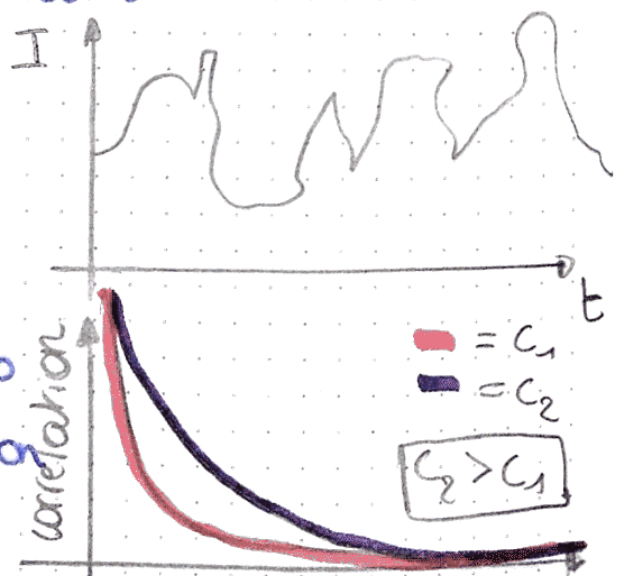
* different methods to analyze the data:

a) Cumulant Method/Algorithm

→ monodisperse solution

b) Pade - Laplace Method/Algorithm

→ polydisperse solution (PDI ≥ 0.1)
polydispersity index



Background:

Brownian motion + Stokes - Einstein

$$P(r, t) = (4\pi D)^{-3/2} \exp(-r^2/4Dt) \quad D = k_B T / 6\pi\eta R_h$$

③ ζ -potential

→ stability of colloid

* electrophoresis

→ 2 electrodes

* measure constant v

→ laser dopler

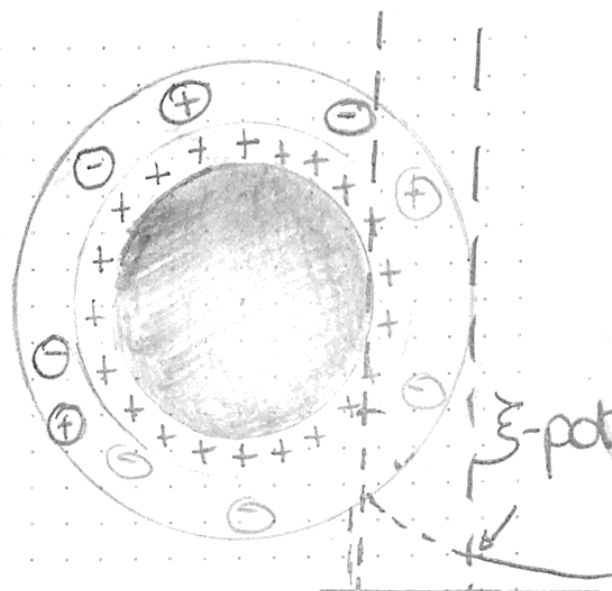
$$E \cdot q = \alpha \cdot v \Rightarrow v = \mu_e \cdot E$$

with $\mu_e = q/\alpha$

* theoretical link ζ -pot:

$$\zeta = \frac{2\eta \cdot \mu_e}{3\epsilon} \quad (\text{Smolouchowski approximation})$$

viscosity medium dielectric constant medium



⇒ if $\zeta \geq 30 \text{ mV}$
stable colloid

④ TEM (Transmission electron microscope)

⇒ size/radius particles

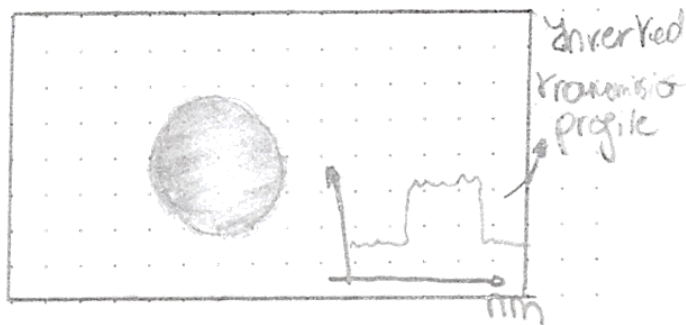
↳ which one?

* heating cathode (tungsten filament)

* e^- move to anode (with hole → beam e^-)

* beam through sample

* transmitted beam → fluorescent plate / electronic picture



! Resolution depends on wavelength

⑤ TGA (Thermogravimetric analysis)

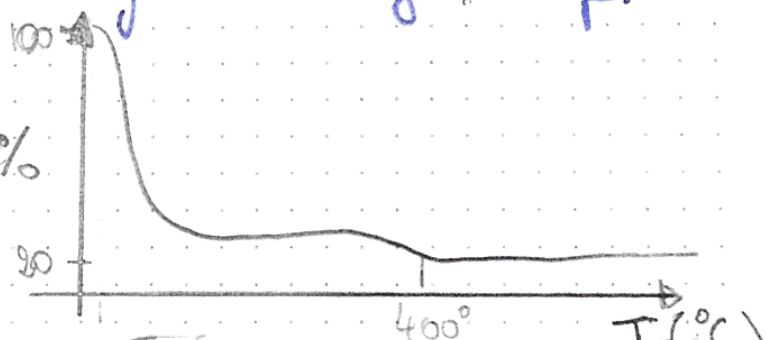
⇒ weight percentage + PEG capping density P_c

* Weight monitoring as a function of Temp.

⇒ mass ratio $\frac{\text{gold}}{\text{PEG}}$

→ $M_{\text{PEG}} + P_{\text{gold}} \rightarrow \text{num. \% ligands/particle}$

→ + surface area: P_c



turnroom vs. Brush → $S = 2 \cdot \sqrt{\frac{1}{\pi e}} \cdot s \geq R \approx a N^V$ Flory radius