

SYNTHESIS OF GOLD NANOPARTICLES AND THEIR LINKAGE TO CNTs

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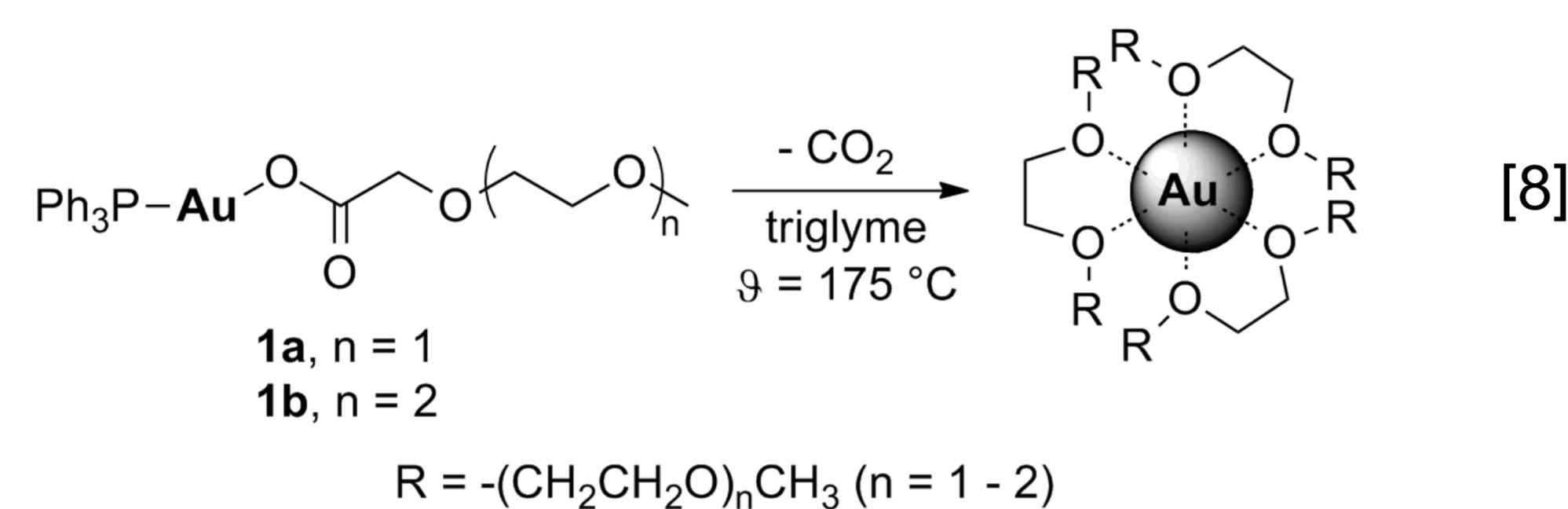
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Motivation

During the last decades nanoparticles (NP) received an increasing interest among chemists, physicists as well as engineers, due to their excellent electric,[1] magnetic[2] and catalytic[3] properties that deviate from the bulk materials.[4] Especially group-11 metal NPs such as gold and silver are well-known for size-dependent optical properties[5] affected by size distribution, shape and interactions between adjacent particles.[6] Therefore, these metal NPs pave the way for establishing new kinds of nanodevices. On the basis of their optical properties, the use of NPs in sensor applications is conceivable. This can be realized for instance in carbon nanotube field-effect transistors (CNTFETs), wherein the transistor channels are functionalized by gold NPs to achieve a selective sensitivity towards external stimuli.[7] Herein, we present the preparation of spherical and aspherical gold NPs by thermal decomposition of gold (I) carboxylates. By adding cetyltrimethylammonium bromide (CTAB) to the reaction mixture it is possible to form metal hexagons and rods.

Synthesis of Spherical Gold Nanoparticles



Scheme 1: Thermolysis of gold (I) carboxylates and schematic view of stabilized Au NPs.

- Preparation of spherical NPs by thermal decomposition of gold(I) carboxylates
 - Triglyme (triethylene glycol dimethyl ether) used as coordinating solvent
 - Single-Source-Precursor: no stabilizers required, e. g. CTAB or PVP (polyvinylpyrrolidone) and reducing agents
 - Short reaction times: formation of NPs with size distribution 3.9 ± 0.7 nm

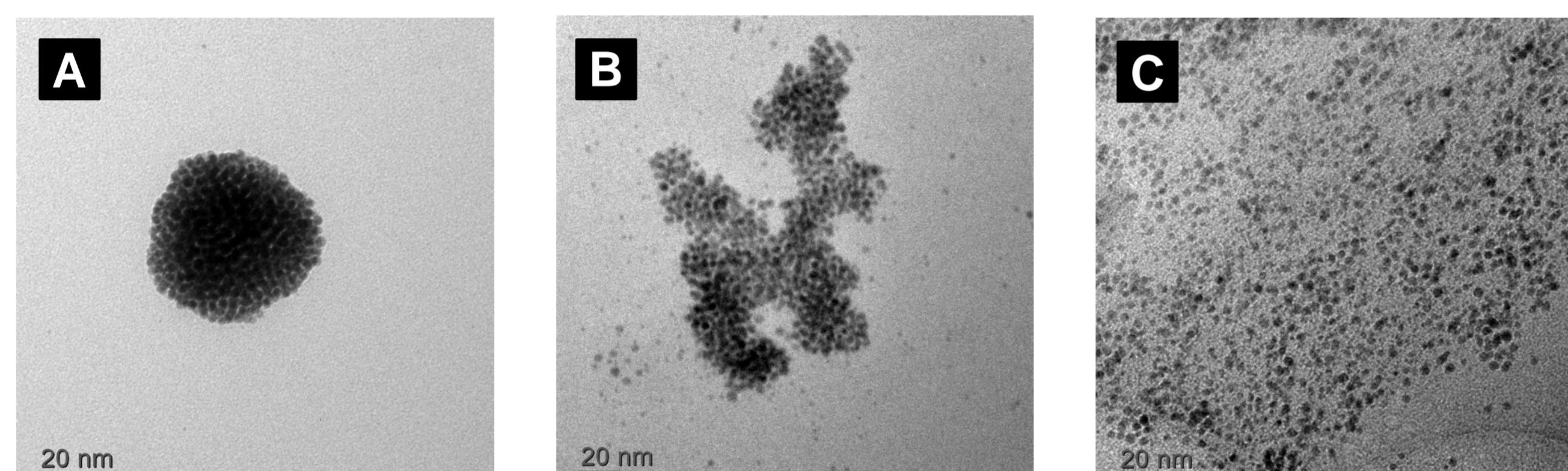
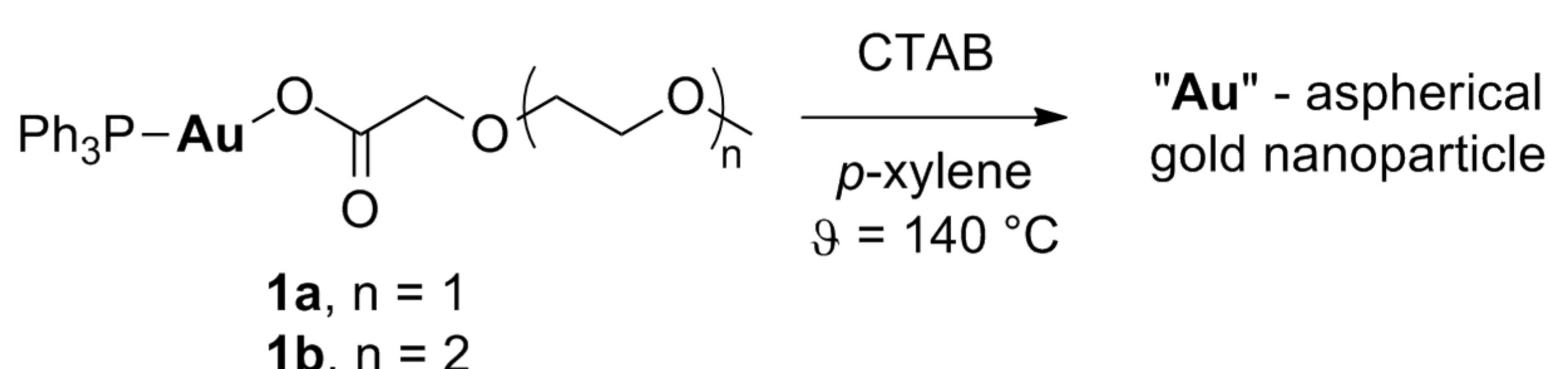


Figure 1: TEM images of received Au NPs by thermal decomposition of 1b ($c = 6$ mmol/L, triglyme) (A) $t = 2:4$ min, $\varnothing = 4.2 \pm 0.8$; (B) $t = 1$ min, $\varnothing = 3.6 \pm 0.7$ nm; (C) $t = 2:4$ min, $\varnothing = 4.0 \pm 0.7$ nm.

Synthesis of Aspherical Gold Nanoparticles



Scheme 2: Thermolysis of gold (I) carboxylates (1a, b) with CTAB as additive.

- Preparation of aspherical Au NPs by thermal decomposition in presence of CTAB as additive
 - Non-coordinating solvent → only stabilization of Au NPs using CTAB
 - Synthesis at lower temperature is possible compared to spherical Au NPs
 - Nanorods growth is possible
 - **Challenge:** separation of differently shaped NPs

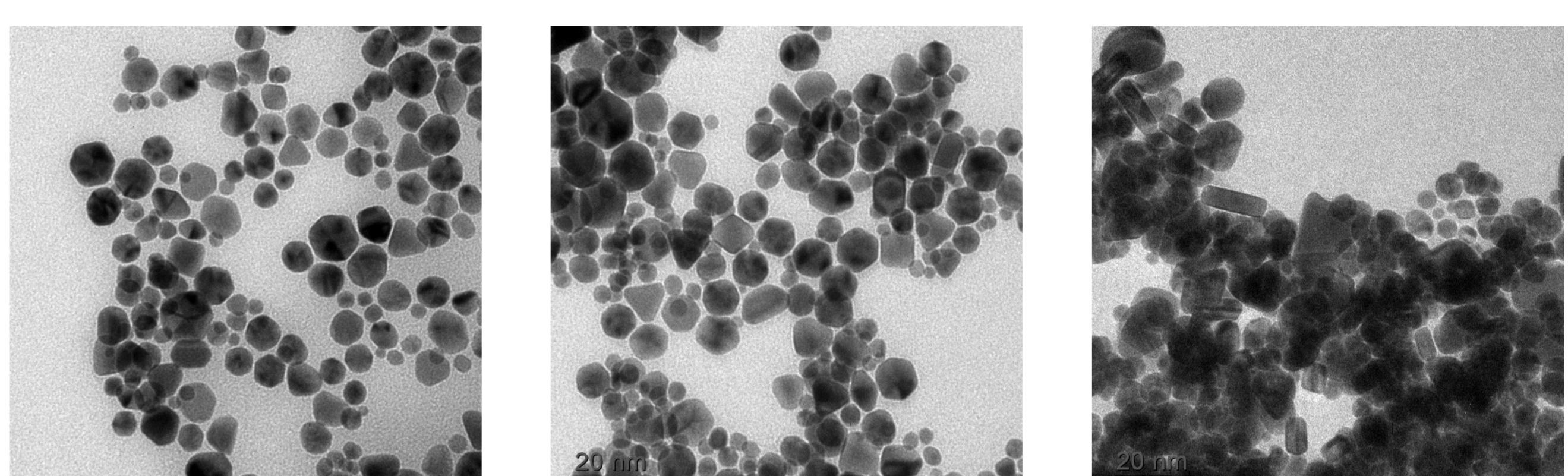
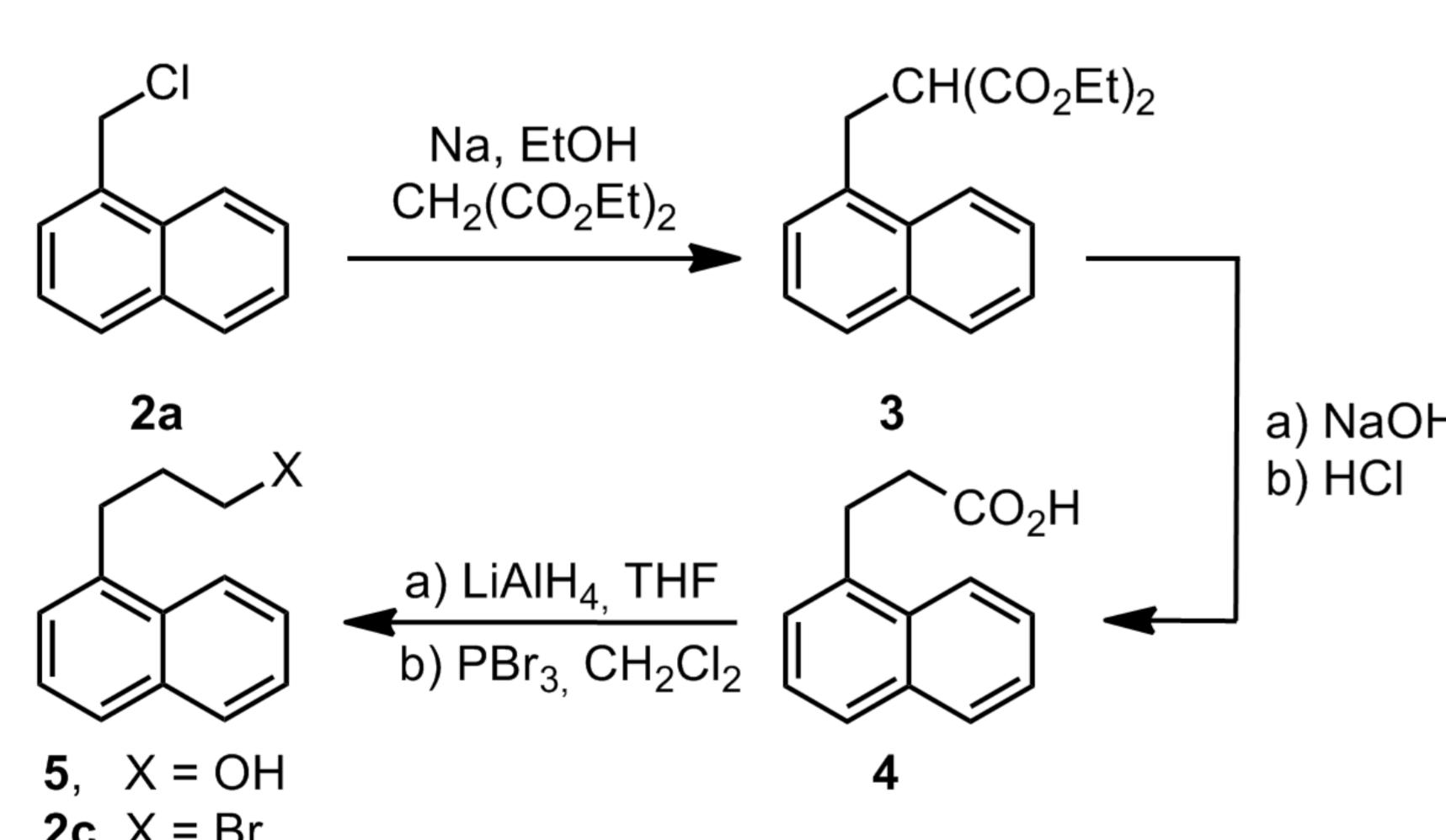


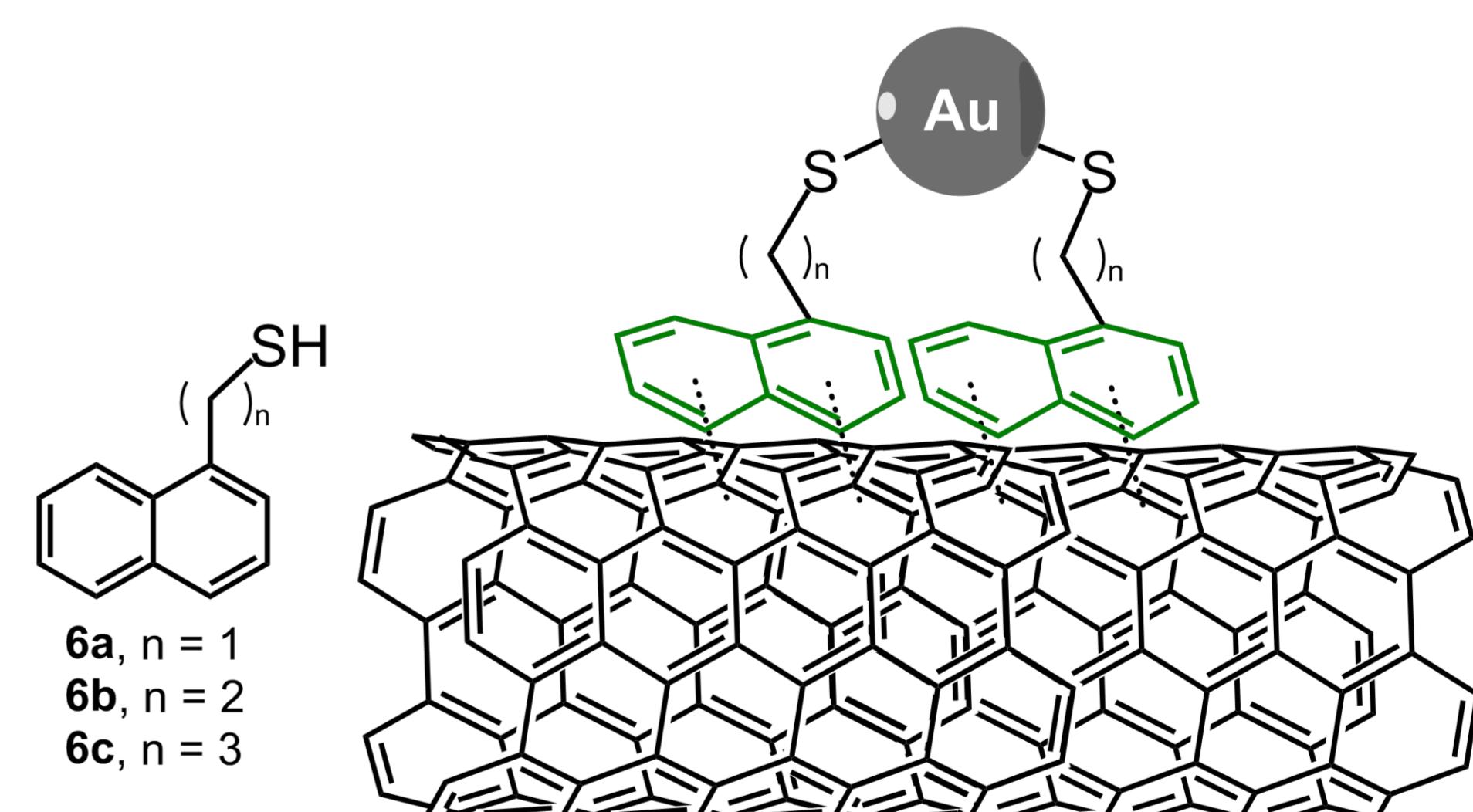
Figure 2: TEM images of aspherical gold NPs prepared by thermolysis of gold (I) carboxylates with CTAB as additive.

Linkage to CNTs



Scheme 3: Synthesis protocol for the preparation of functionalized naphthalene derivatives 2c and 5.^[9]

- Naphthalene thiols as linking unit between Au NPs and CNTs
 - π - π interactions with CNTs
 - Functionalized with alkyl chains as spacer unit
 - Investigation of the influence of chain length on the electric and sterical properties of the interaction between Au NPs and CNTs
 - End-grafted thiol functionalization, specific for gold complexation



Scheme 4: Representation of naphthalene derivatives 6a-c as linking unit between Au NPs and CNTs.

Summary

- Preparation of spherical and aspherical Au NPs by thermal decomposition from Single-Source gold (I) carboxylates
- Spherical NPs: narrow size distribution (3.9 ± 0.7 nm)
- Synthesis without stabilizer and reducing agents

- Aspherical NPs: Nanorods growth is possible
- Synthesis at lower temperature is possible compared to spherical Au NPs
- Non-coordinating solvent → only stabilization of Au NPs using CTAB
- Naphthalene thiols as linking unit between Au NPs and CNTs

References

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