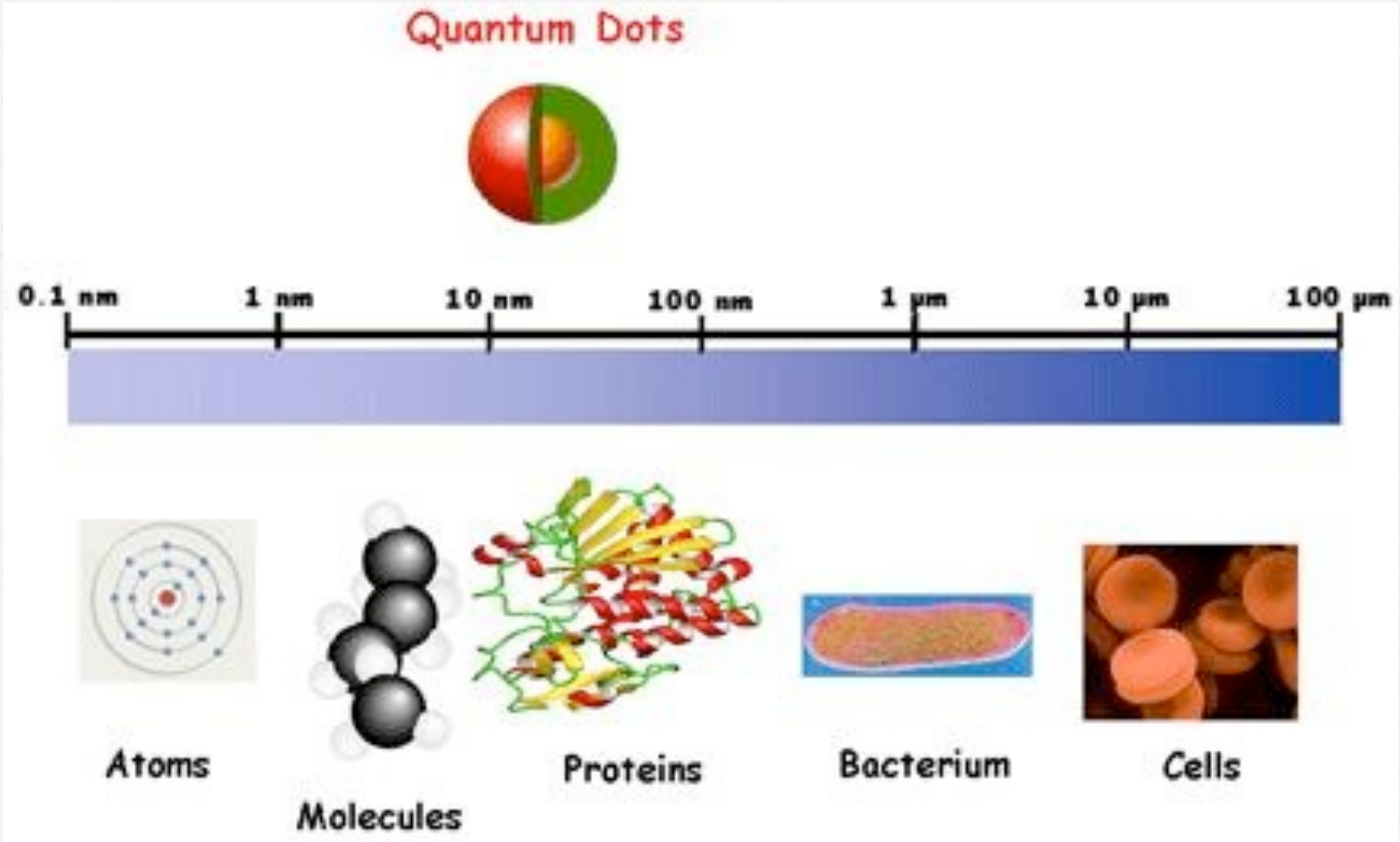
nanoparticles

a new field of science

Atoms/ Molecules	Nanoscale Particles	Condensed Matter
1	125 70,000	6×10^{6} ∞N°Atoms
	1 10	100 ∞ Diameter (nm)
Quantum Chemistry	?	**Solid State Physics**

sizes


Quantum Dots
0.1 nm
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
Atoms
Molecules
Proteins
Bacterium
Cells

classification of nanomaterials

Cluster A collection of units (atoms or reactive molecules) of up to about 50 units. Cluster compounds are such moieties surrounded by a ligand shell that allows isolation of a molecular species (stable, isolable, soluble).

Colloid A stable liquid phase containing particles in the 1-1000 nm range. A colloidal particle is one such 1-1000 nm sized particle.

Nanoparticle A solid particle in the 1-1000 nm range that could be noncrystalline, an aggregate of crystallites, or a single crystallite.

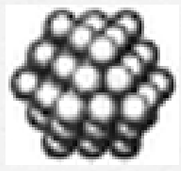
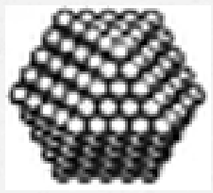
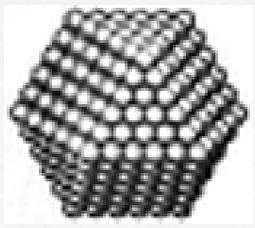
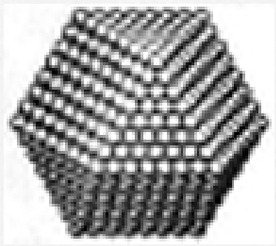
Nanocrystal A solid particle that is a single crystal in the nanometer size range.

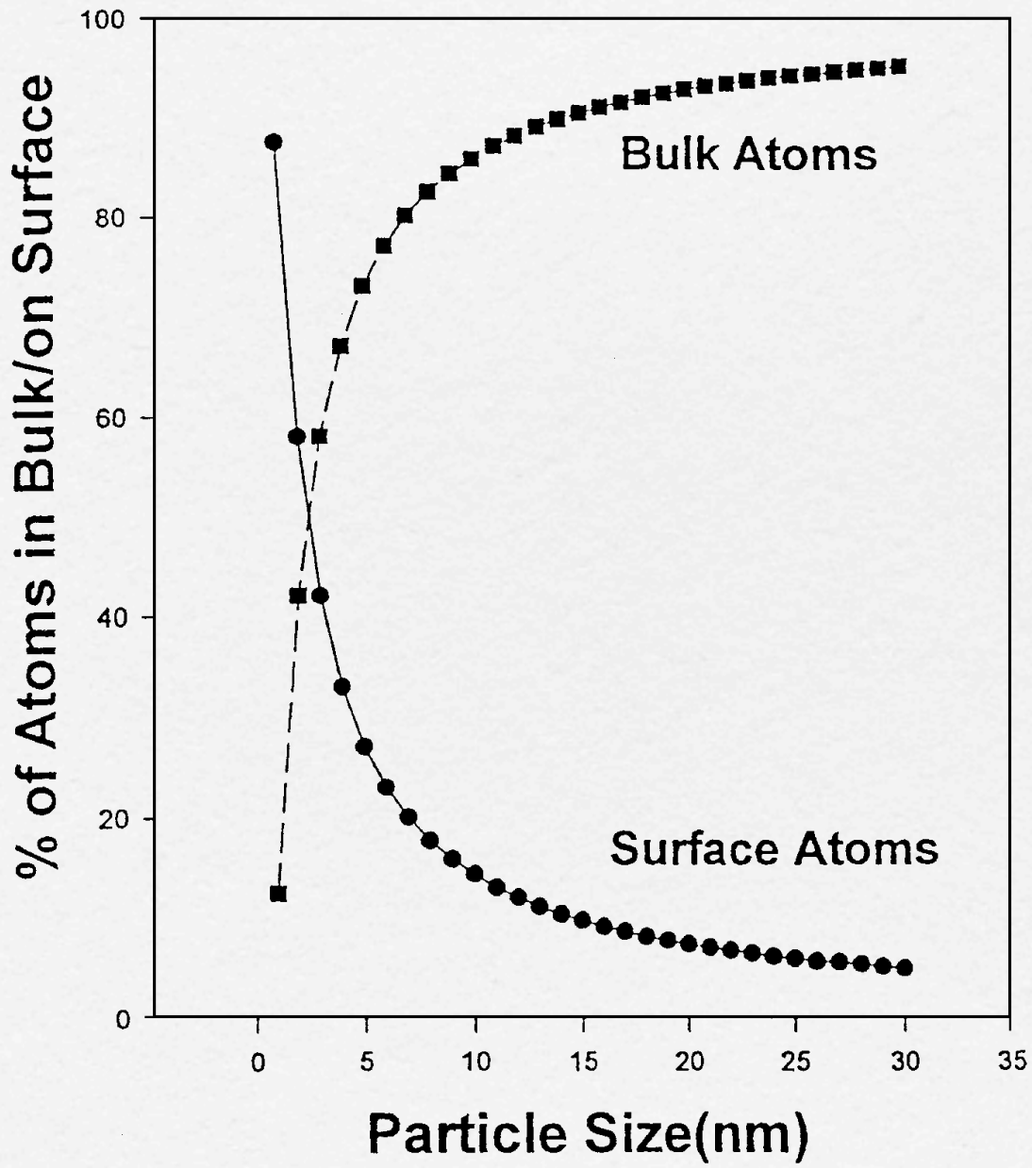
Nanostructured or nanoscale material Any solid material that has a nanometer dimension; three dimensions --> particles; two dimensions --> thin films; one dimension --A thin wire.

Nanophase material The same as nanostructured material.

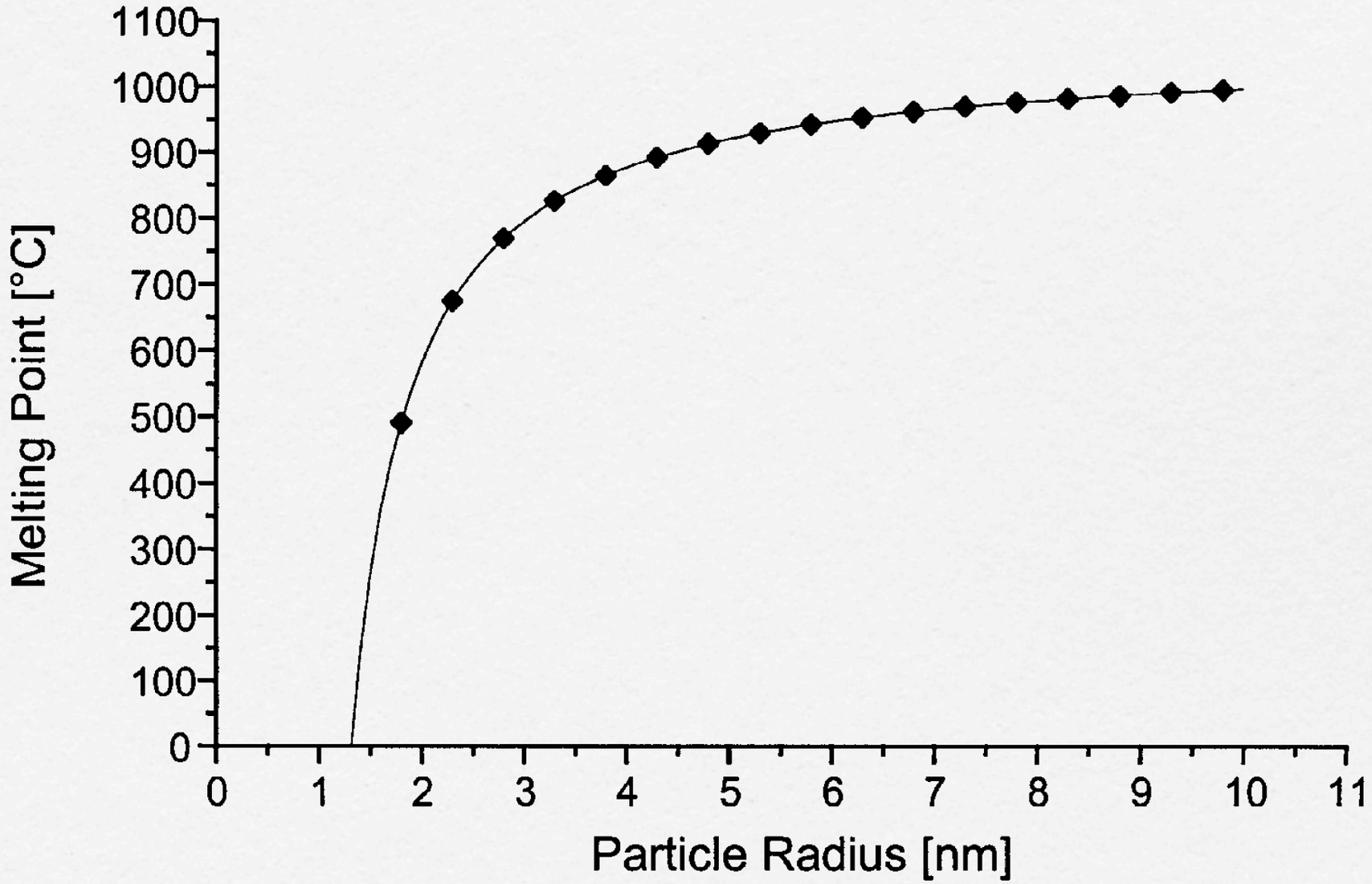
Quantum dot A particle that exhibits a size quantization effect in at least one dimension.

surface effects

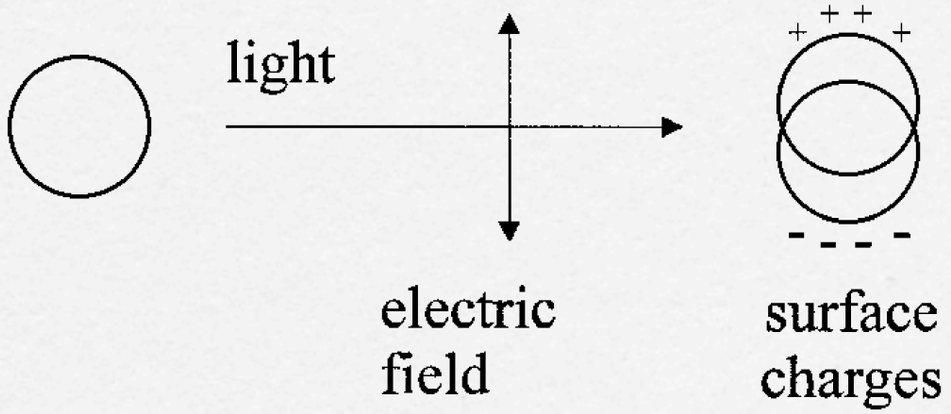
Full-shell Clusters		Total Number of Atoms	Surface Atoms (%)
1 Shell		13	92
2 Shells		55	76
3 Shells		147	63
4 Shells		309	52
5 Shells		561	45
7 Shells		1415	35

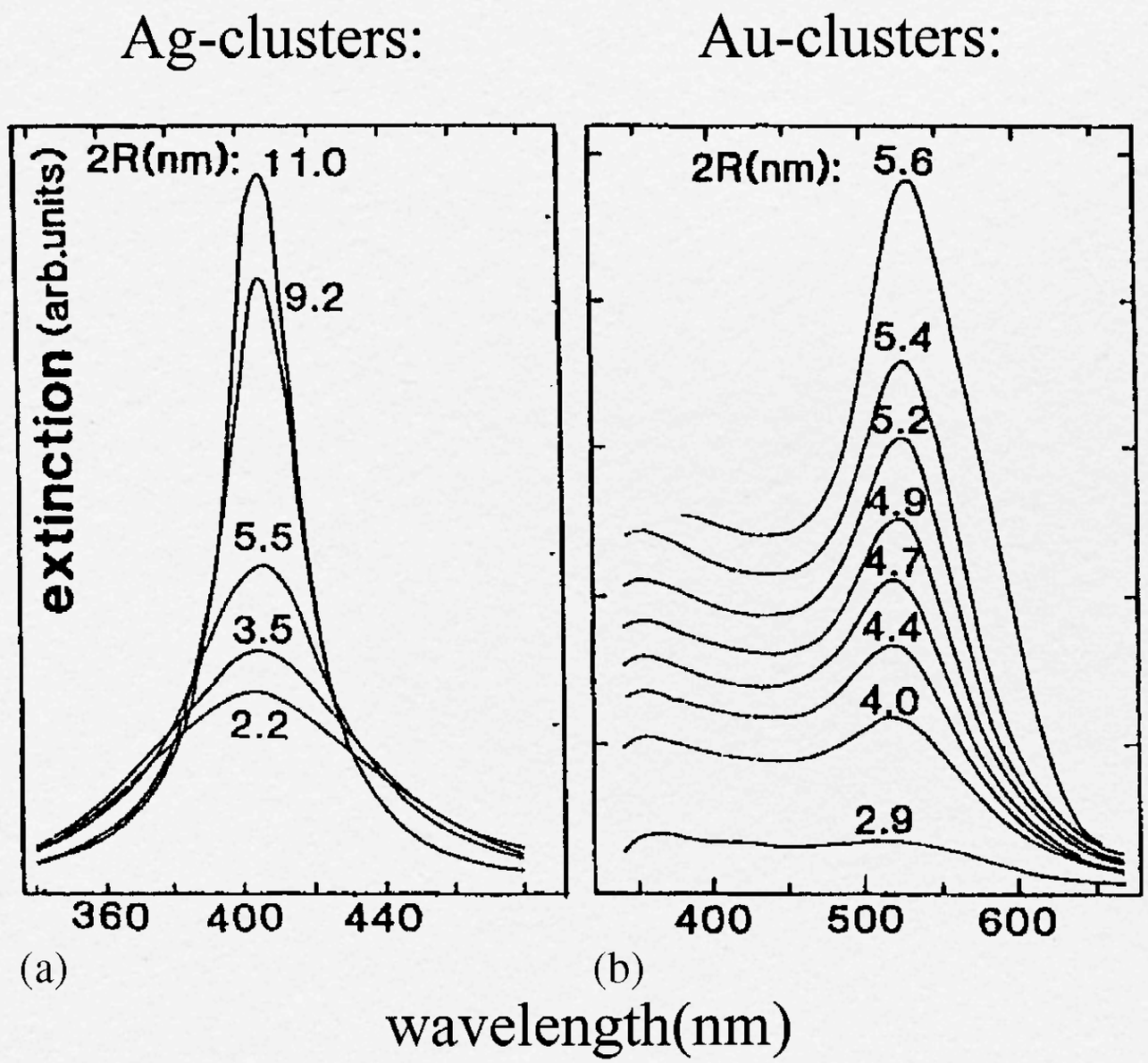


surface effects: AuNP melting

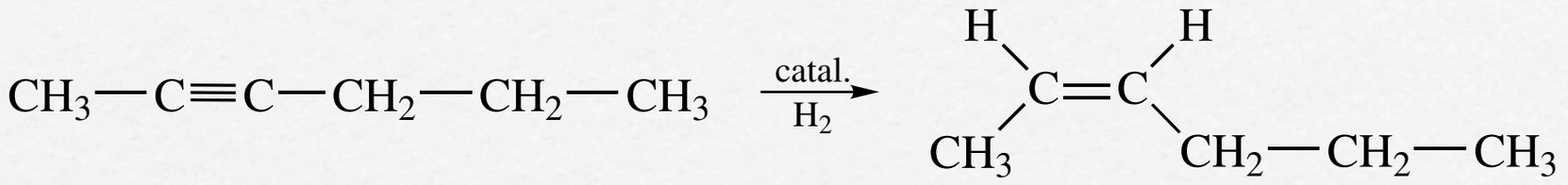


surface effects: colors



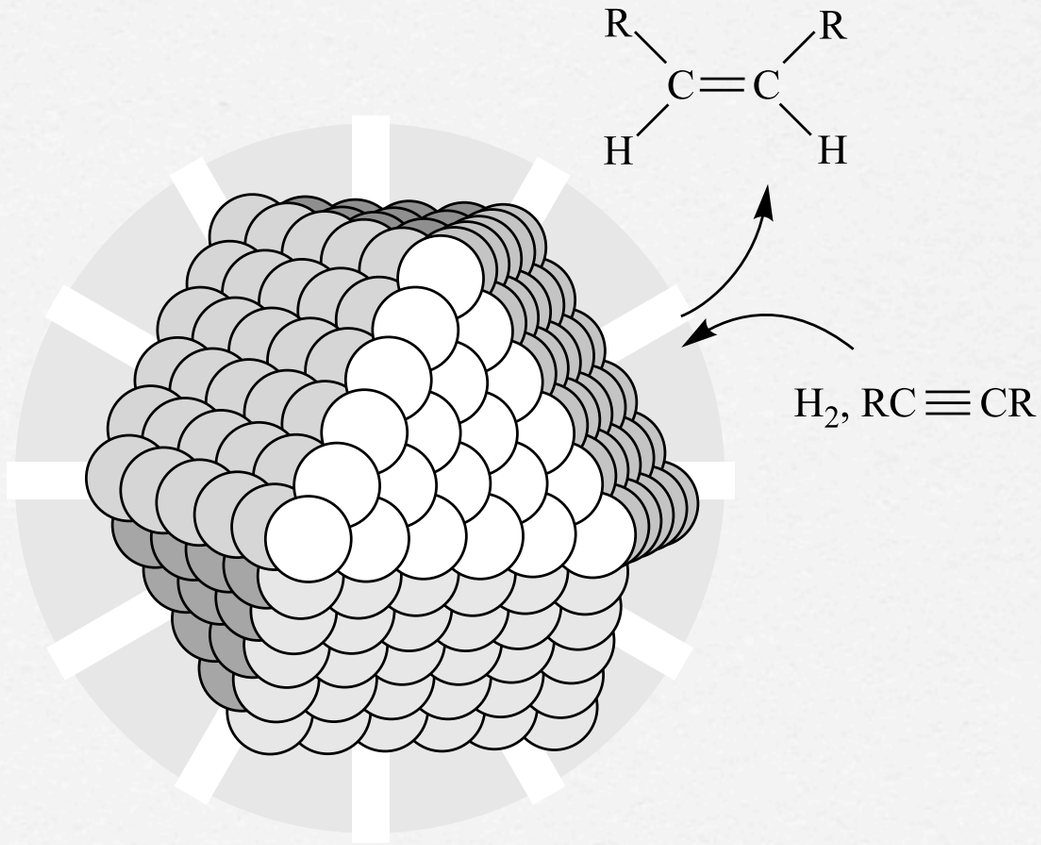


surface effects: catalysis

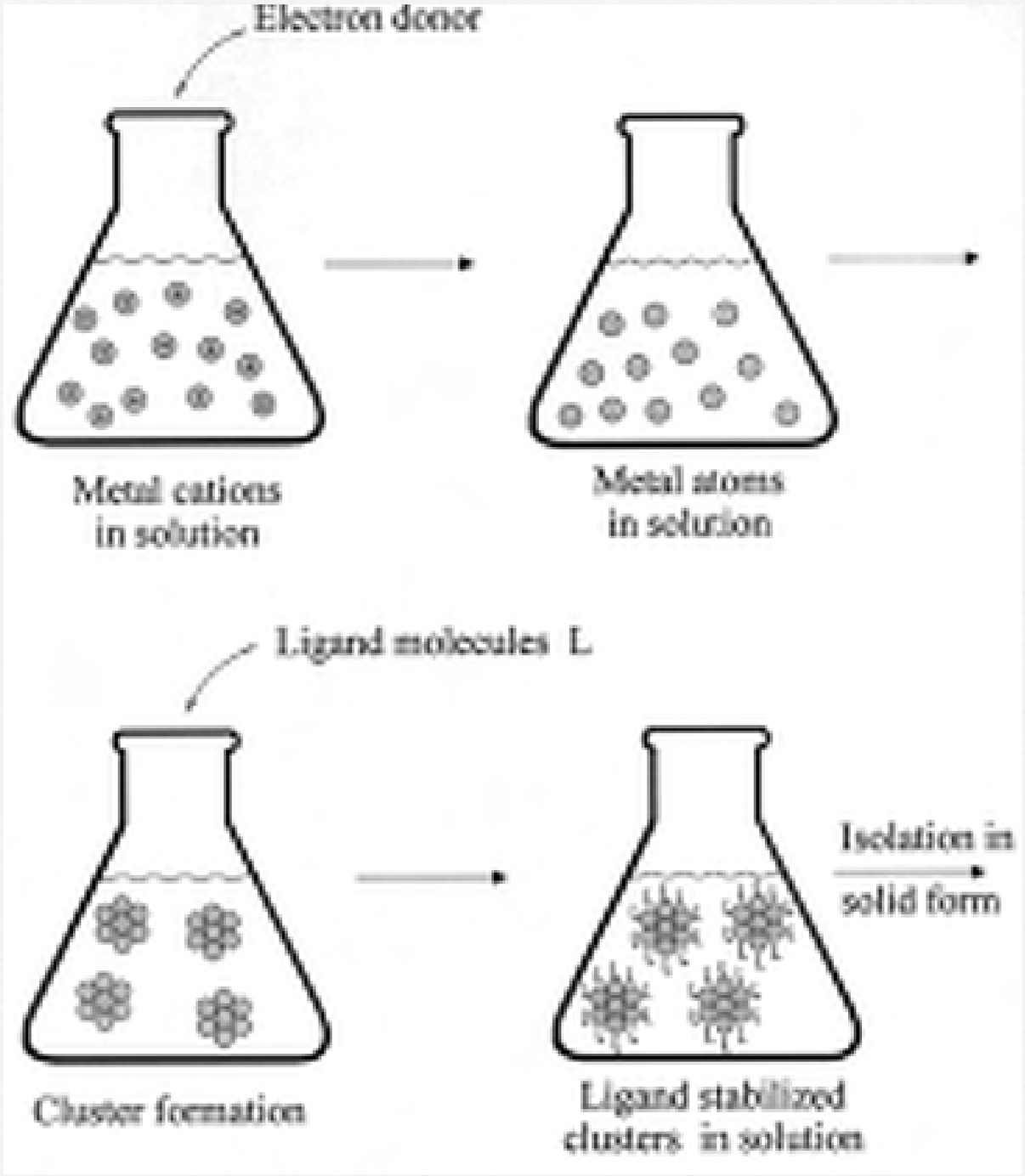


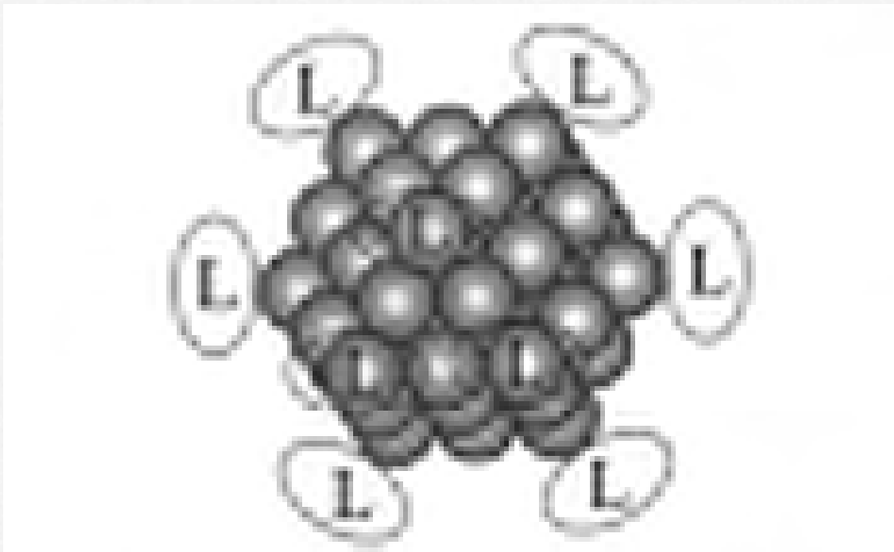
2-hexyne *cis*-2-hexene

(2.7)

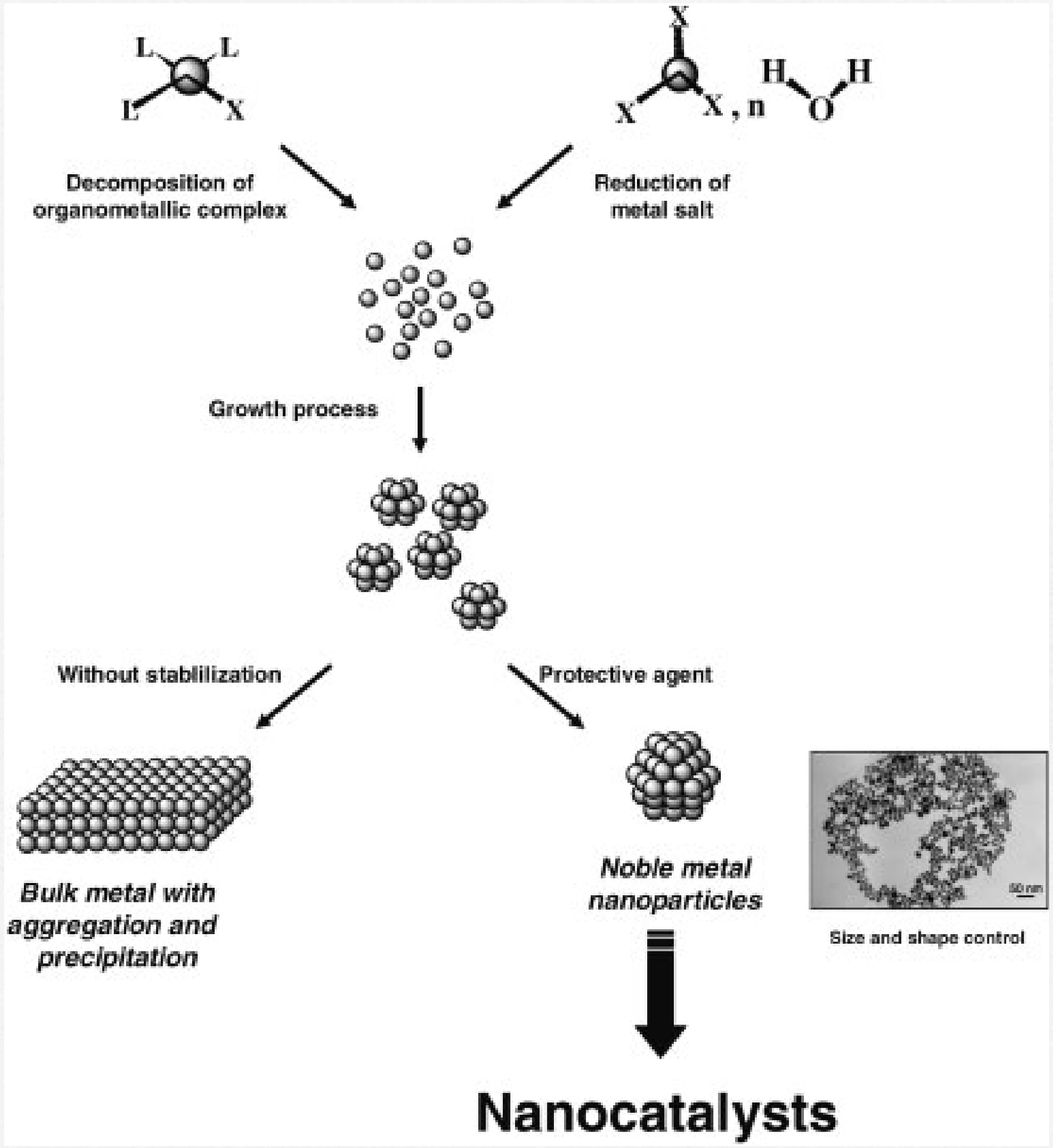


cluster synthesis





synthesis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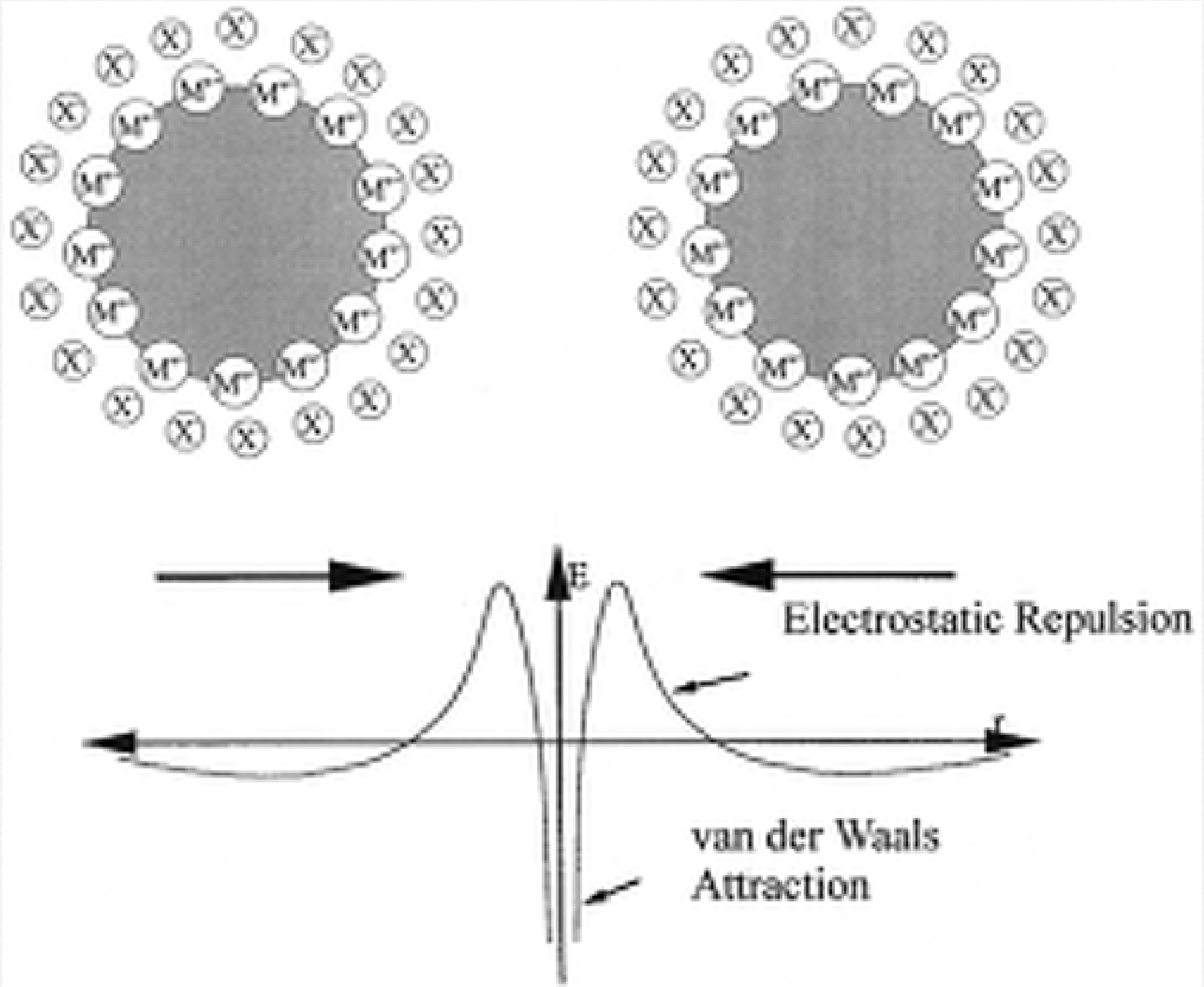
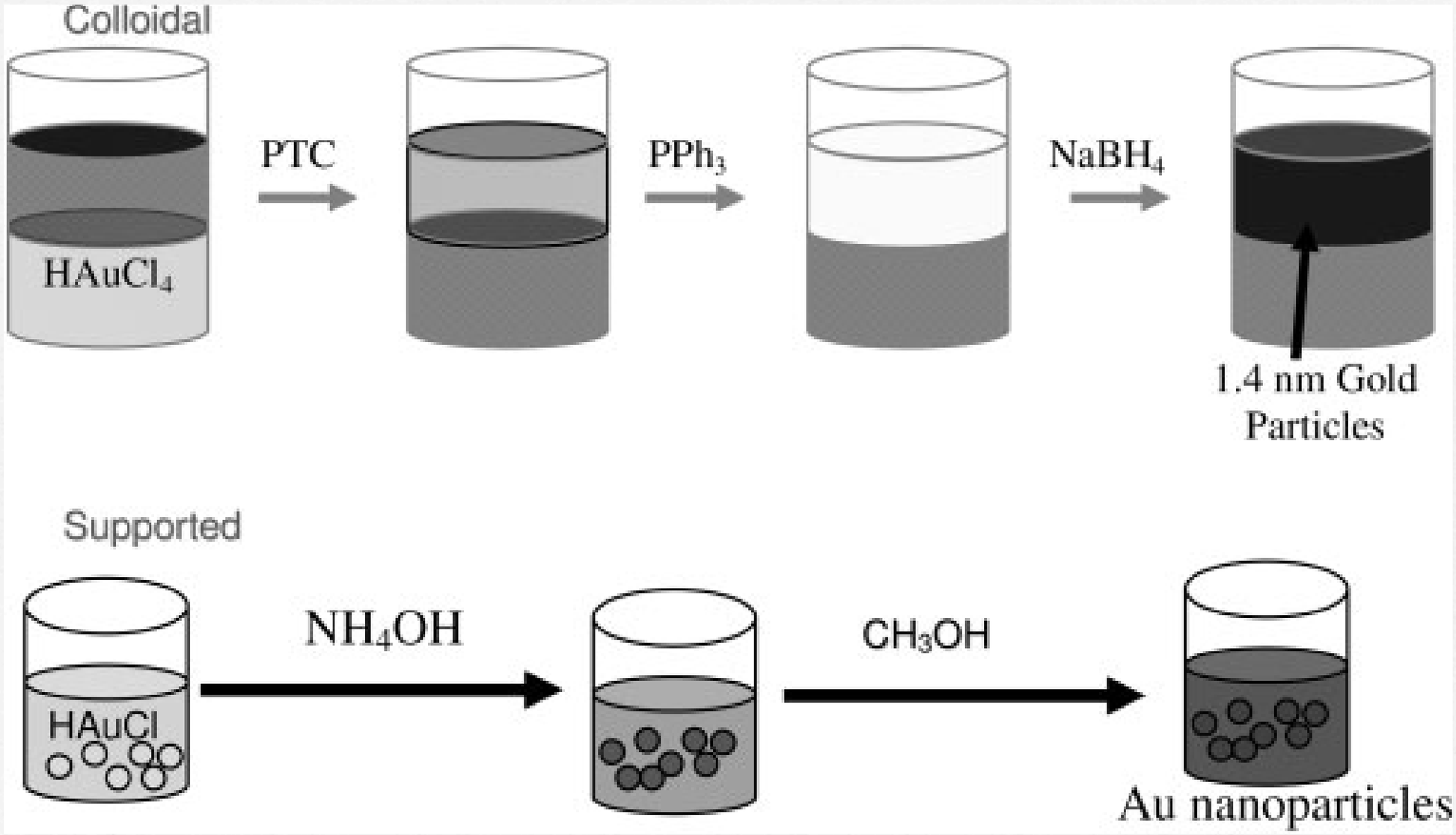
Decomposition of organometallic complex
Reduction of metal salt
Growth process
Without stablilization
Protective agent
Bulk metal with aggregation and precipitation
Noble metal nanoparticles
Size and shape control
Nanocatalysts

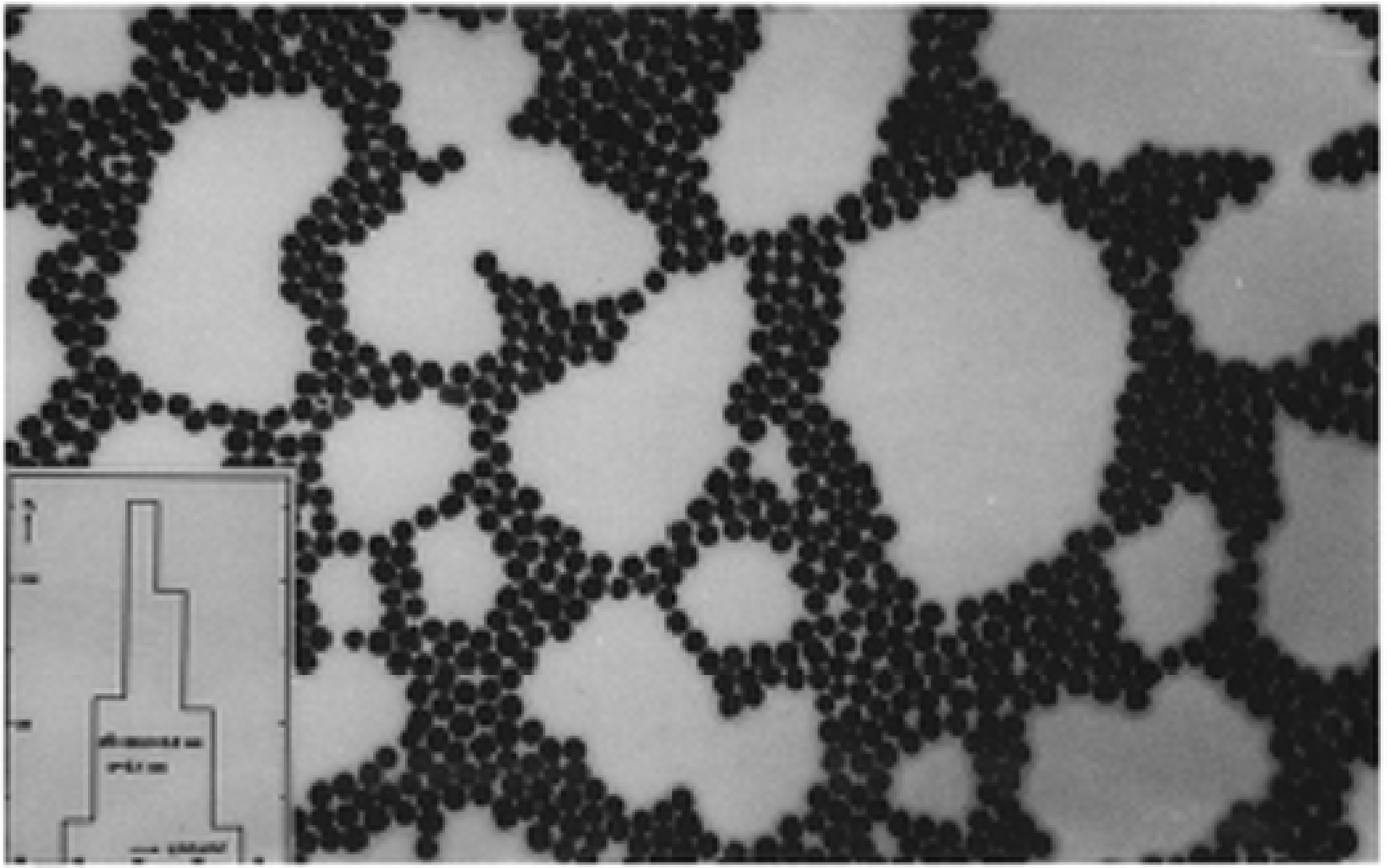
electrostatic stabilization of NP



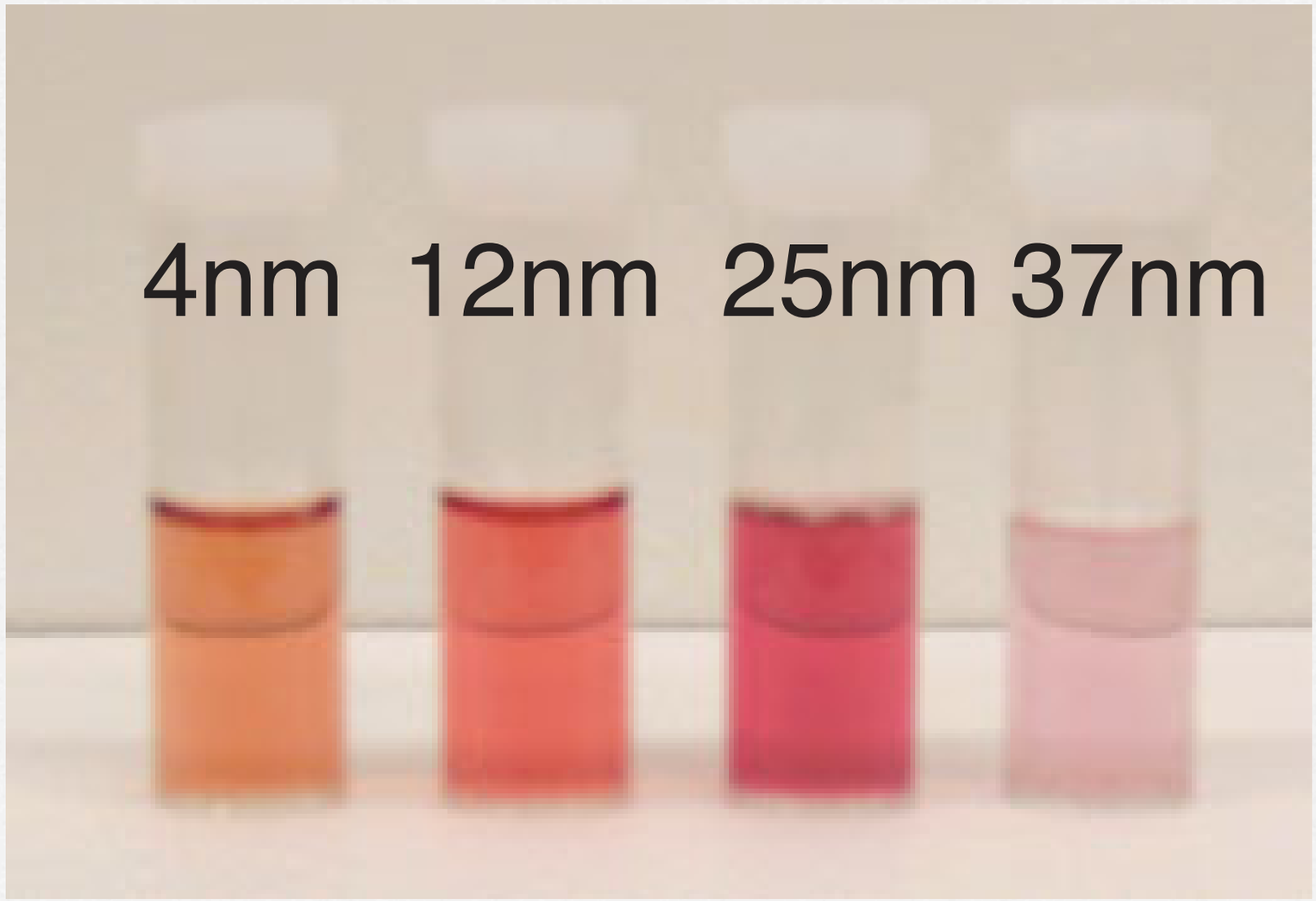
AuNP synthesis



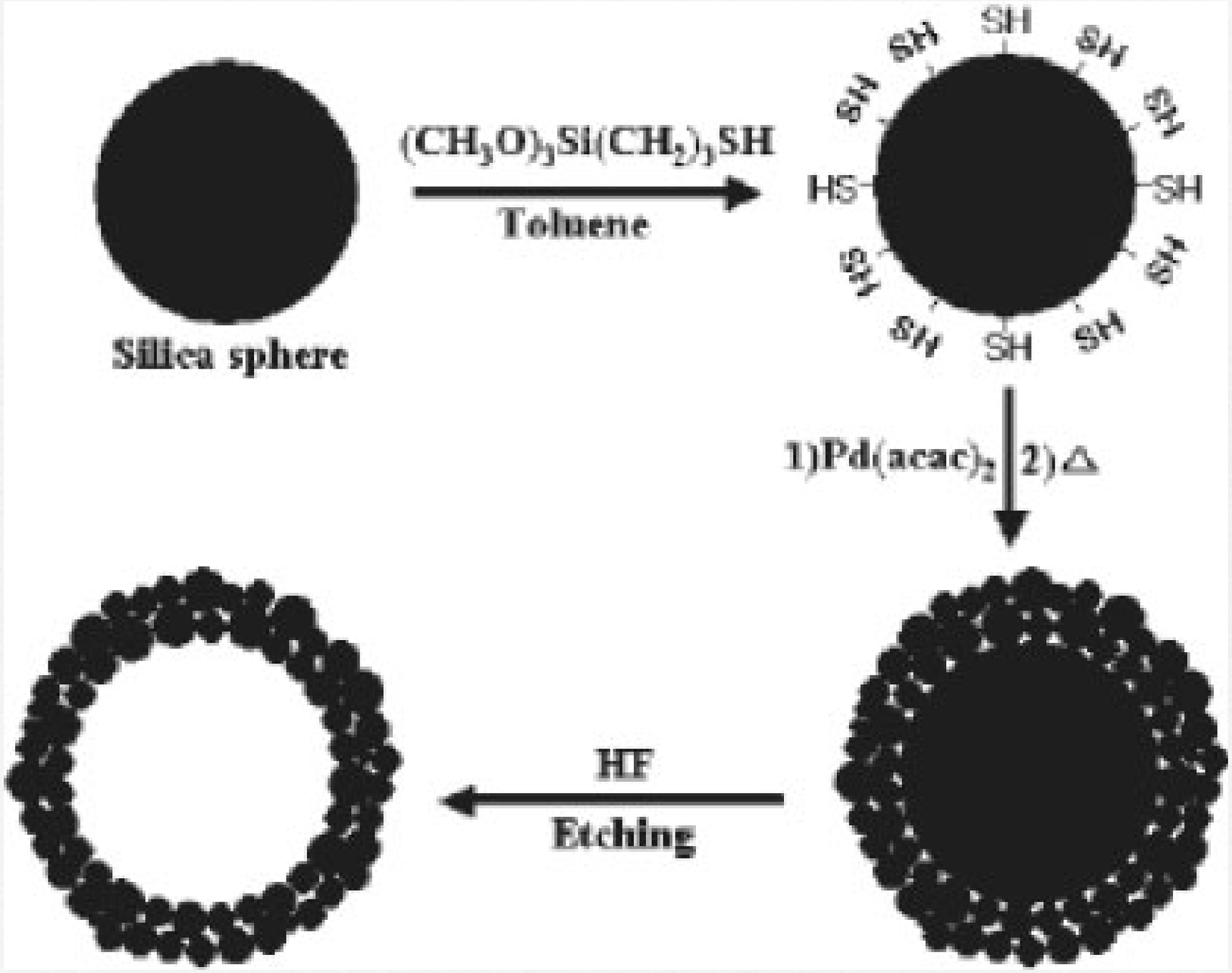
ligand stabilized AuNP



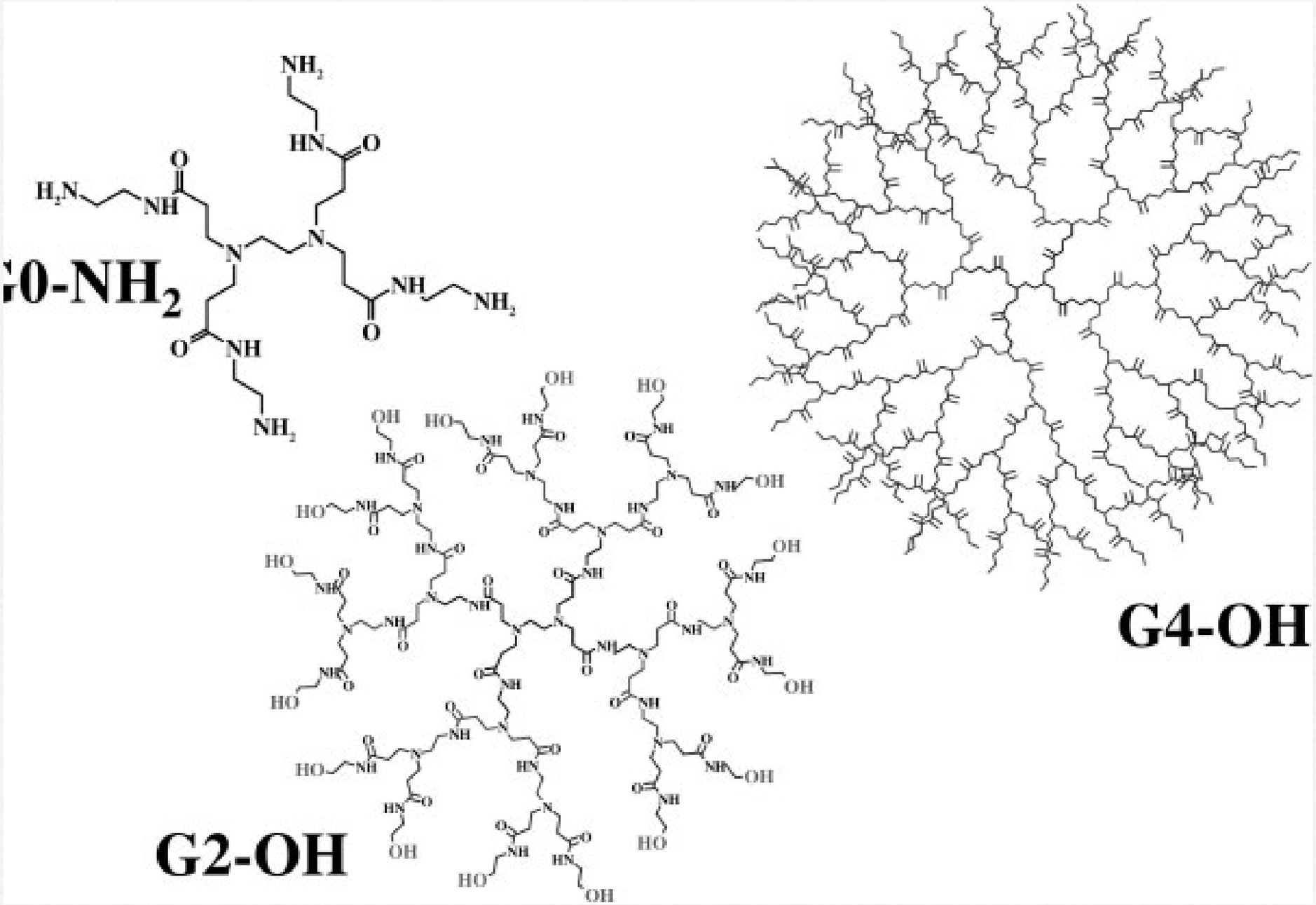
ligand stabilized AuNP



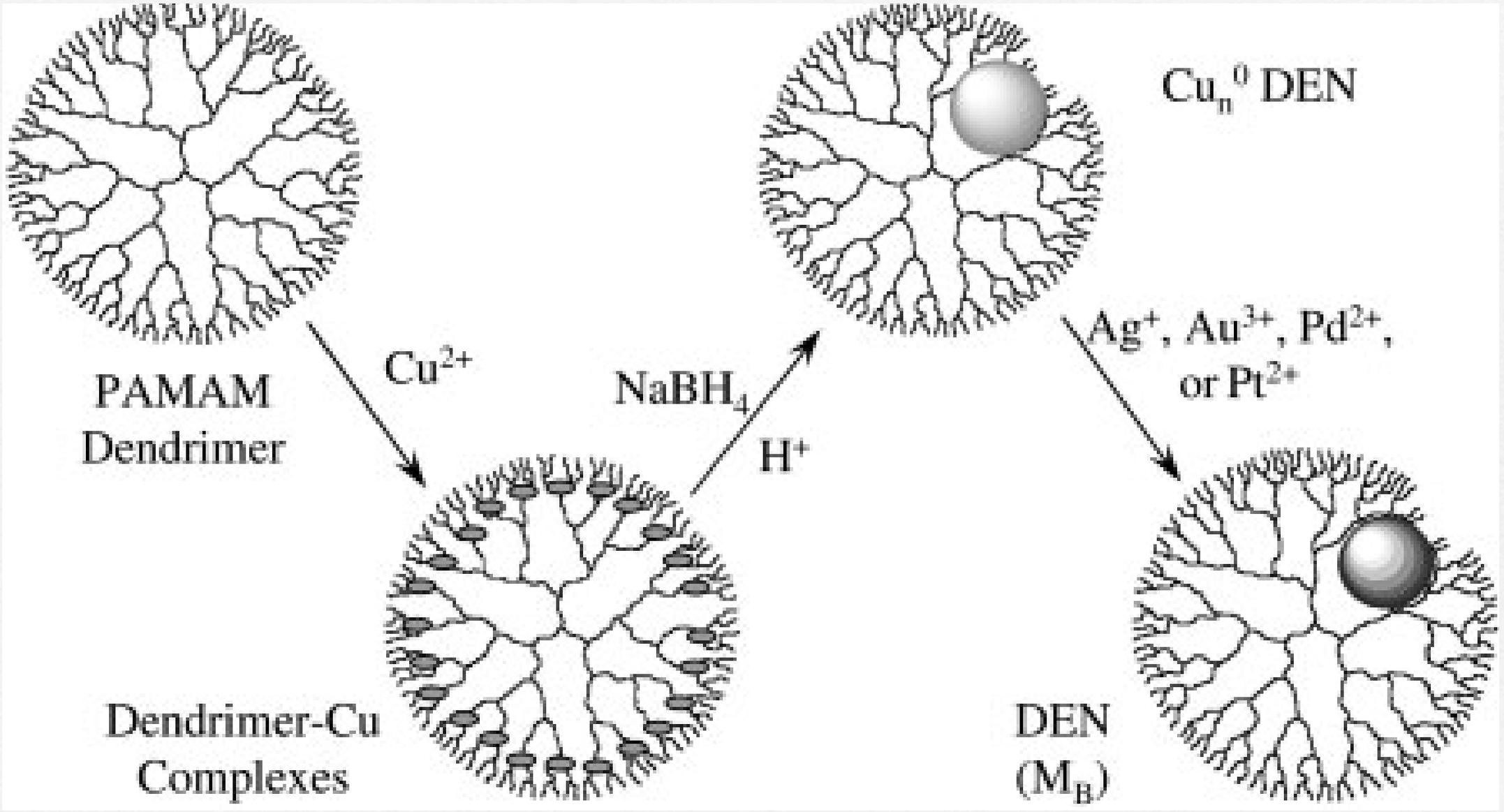
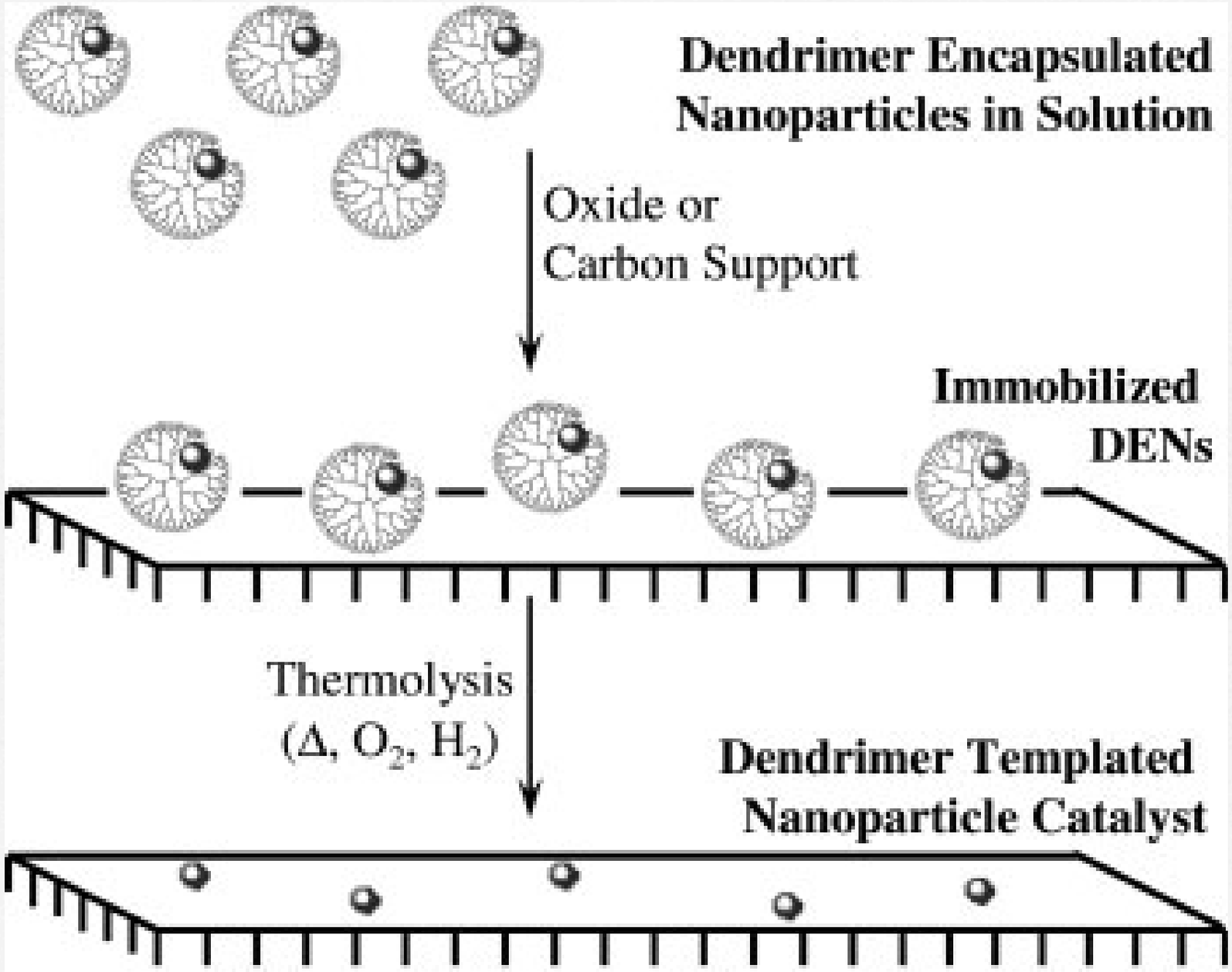
hollow arrangements



NPs in dendrimers



NPs in dendrimers



NPs in dendrimers