

# **Zero-Dimensional Nanostructures: Nanoparticles**

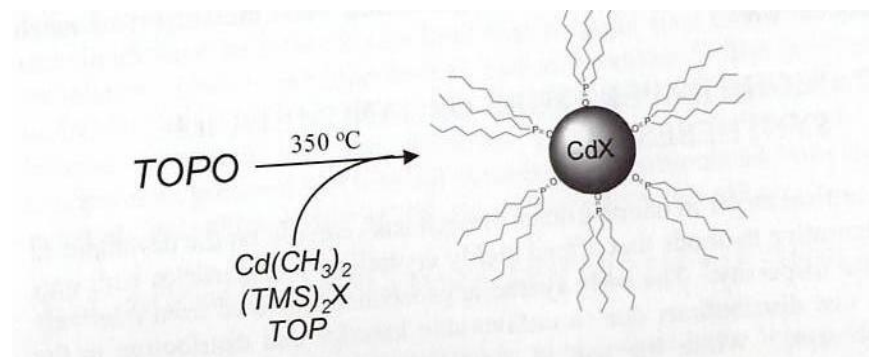
**Synthesis of Au, Ag and other  
Nanoparticles**

Semana 7

# Semiconductor Compound Nano Particles

High Temperature Organo-Metallic Methods are still the most popular for both III-V and II-VI compound.

- Thermal decomposition.
- Rapid injection of organometallic precursor means fast nucleation.
- The following growth can be controlled and terminated by adjusting temperature



<https://www.youtube.com/watch?v=bNuoYm7Su4o>

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# Au nanoparticles: Is it New?



“Labors of the Months” (Norwich, England, ca. 1480)  
(The ruby color is probably due to gold nanoparticles.)

# Au nanoparticles: Is it New?



Lycurgus Cup that was manufactured in the **5th to 4th century B.C.**

It is ruby red in transmitted light and green in reflected light, due to the presence of gold colloids.

# Nano-sizing Causes Changes In Color

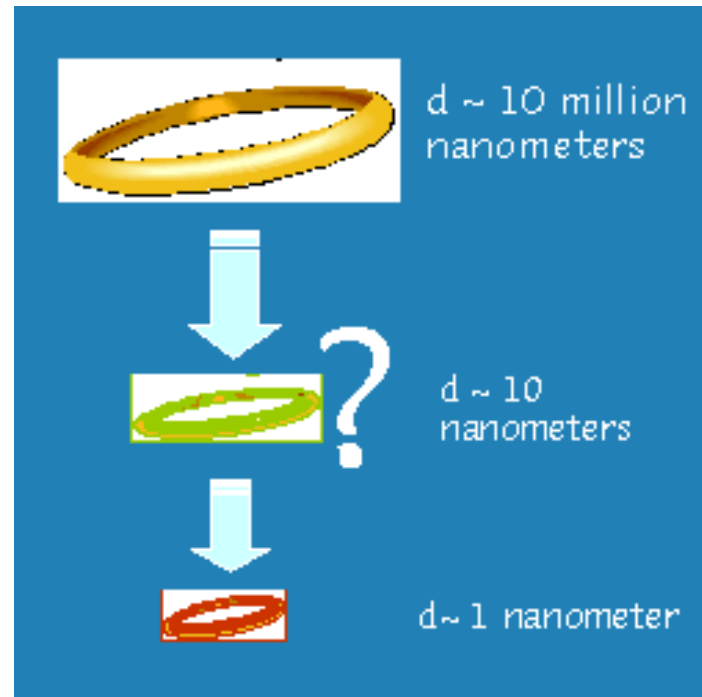
## Macroscale vs. Nanoscale Gold



Why ?

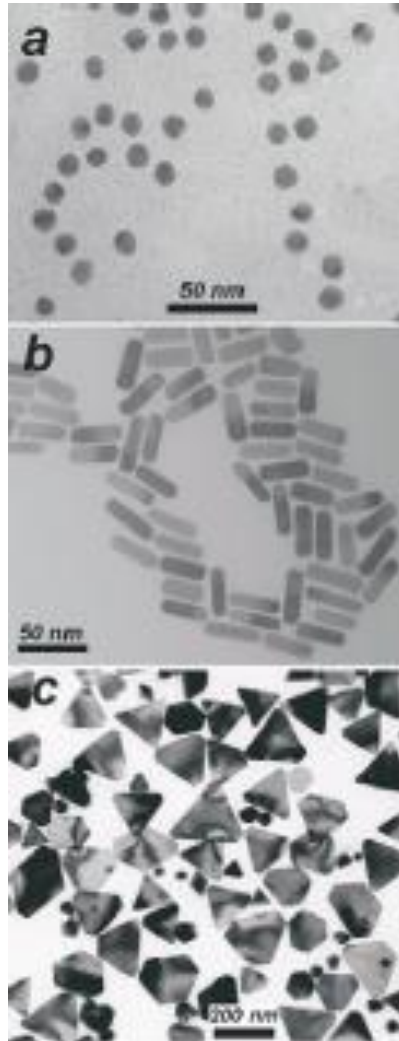
Does something else changes?

# Why Nano Gold Particles?



The optical applications of nano materials

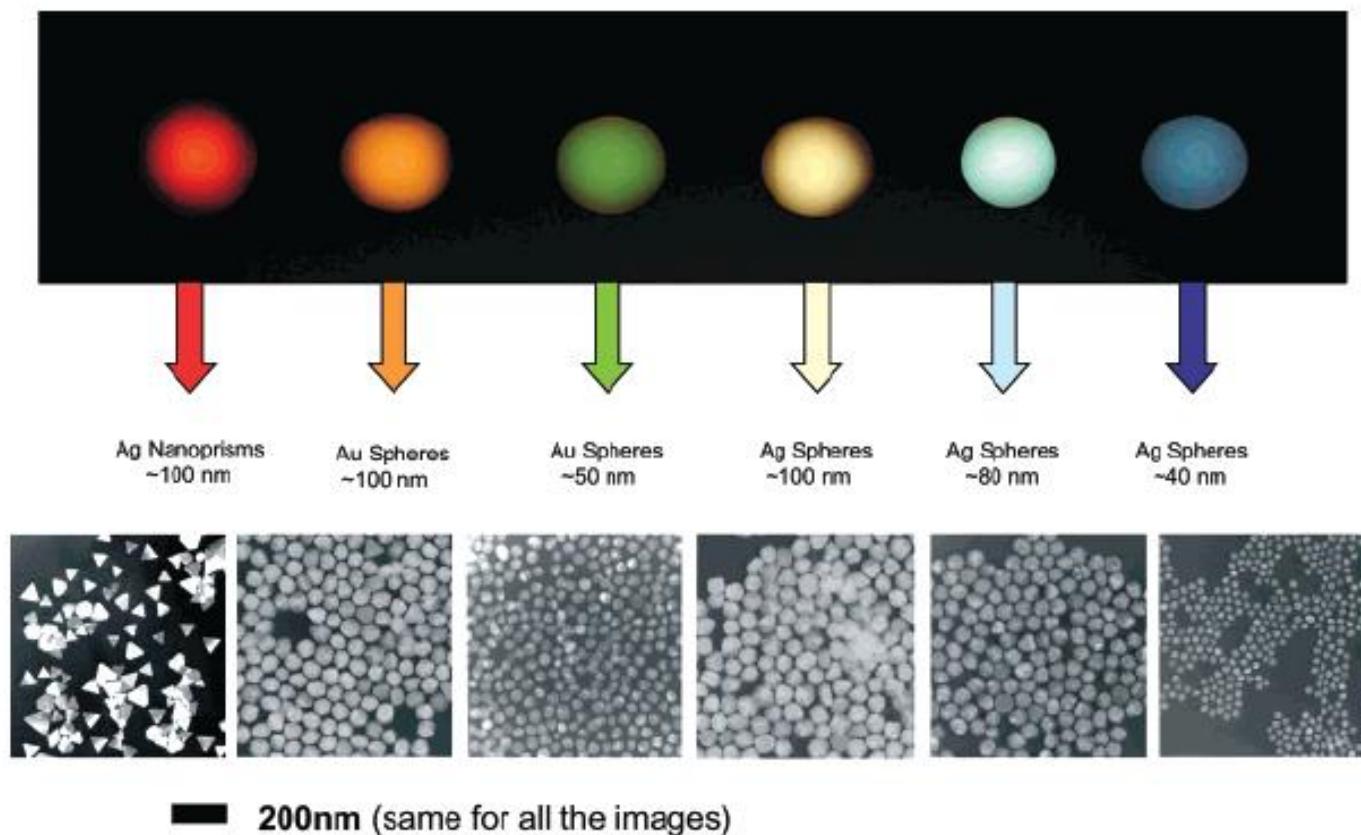
# Metal Nanoparticles: Color depends on shape and size



Luis M. Liz-Marzán, *Materials Today*, **2004**, 26-31.

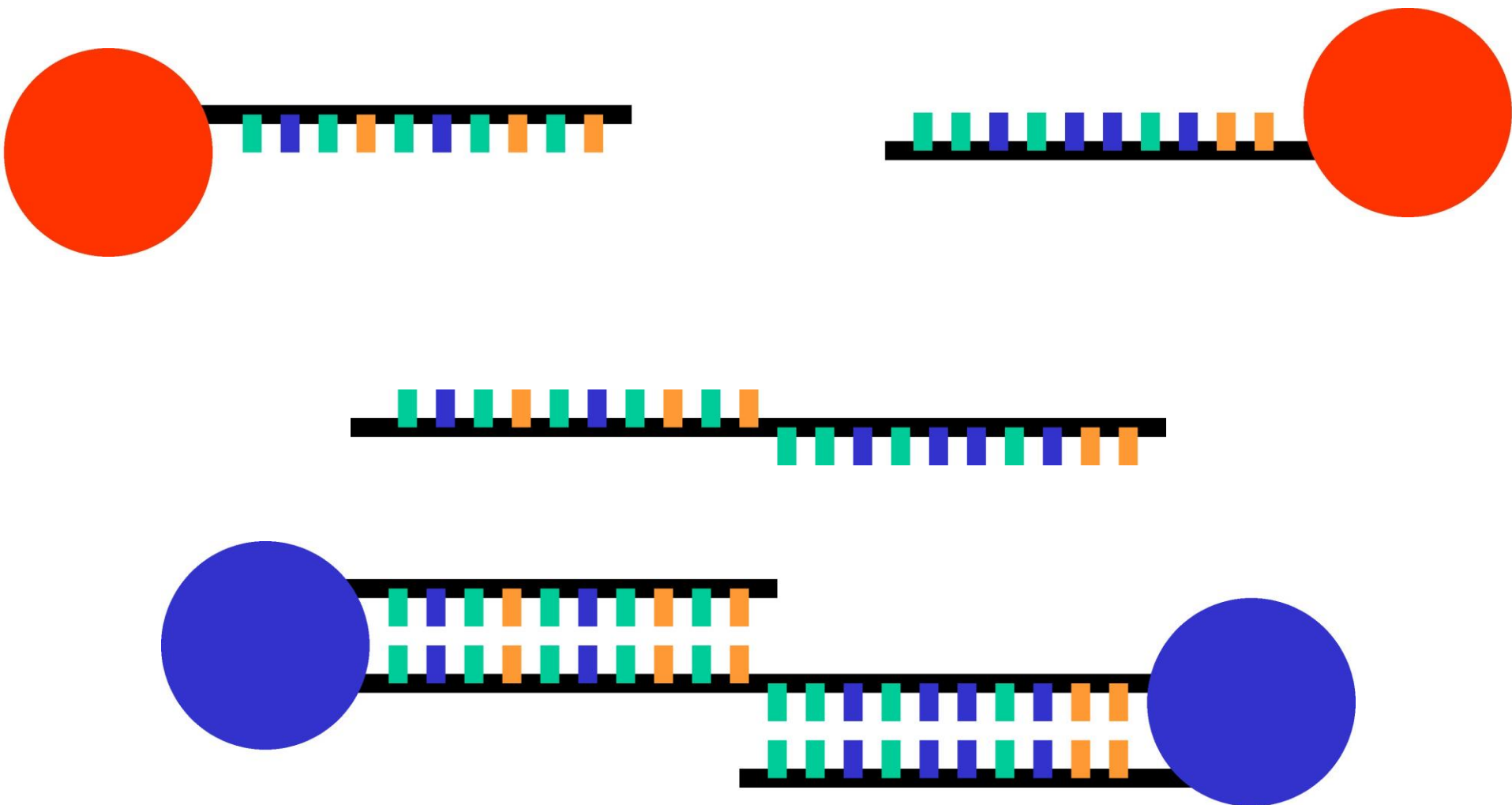


# Metal Nanoparticles: Color depends on shape and size



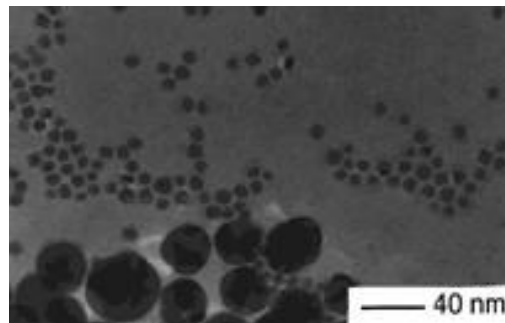
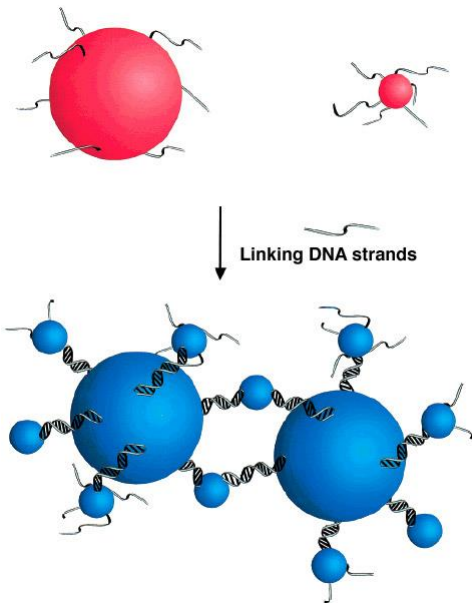


# Au nanoparticles: Applications

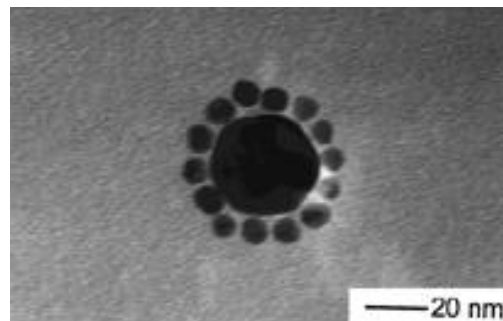


# Au nanoparticles: Applications

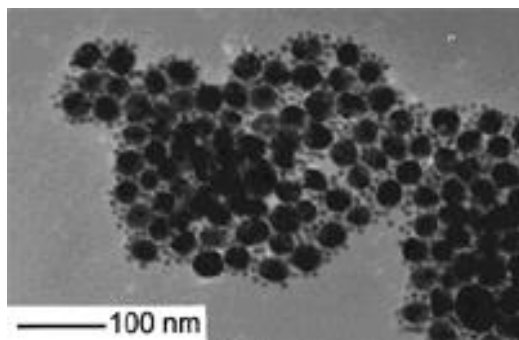
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8 and 30 nm  
gold particles,  
no DNA link



8 nm and  
excess 30 nm  
gold particles,  
DNA link



8 and 30 nm  
gold particles,  
DNA link

# Ag nanoparticles: Applications

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Silver Wash, as the name implies, uses real silver. Microscopic bits of electrolyzed silver (about 400 billion silver particulates) are dispersed and dissolved into the wash water, where they infiltrate fabrics on an almost molecular level. The silver nanoparticles kill 99.9% of bacteria and fungi, says the manufacturer.



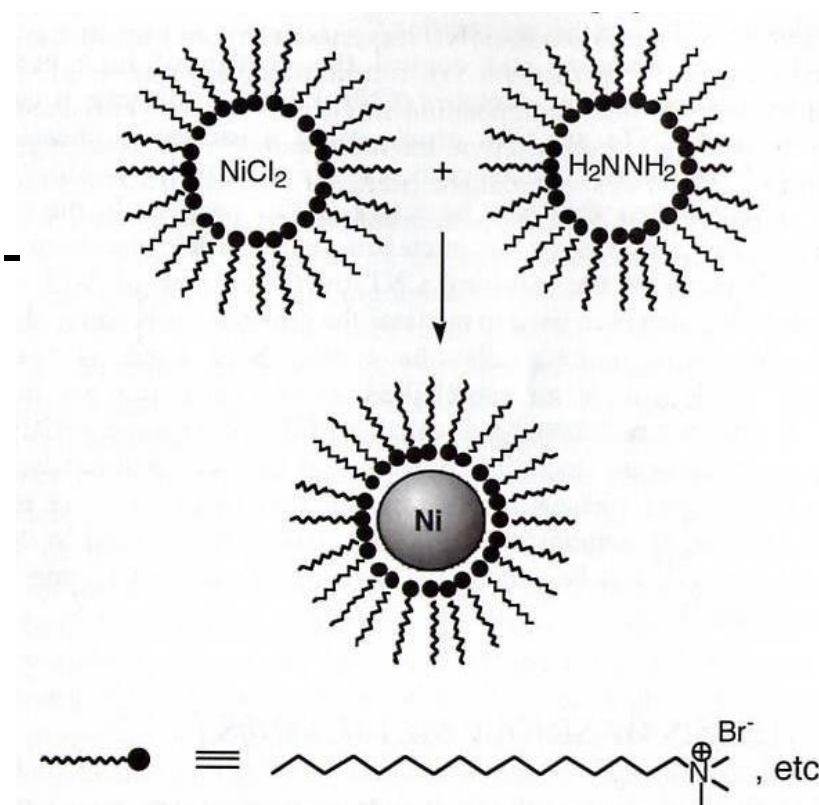
The silver nanoparticles in Fresh Box containers naturally kill bacteria and limit mold growth without toxins.



# Synthesis of Single Metal MNP

## -- Method I: The Reduction of Metal Salts

- Size control: conducting the reaction in a confined reactor
- Nano confined reactor such as water-in-oil or oil-in-water micro-emulsion system
- Size of confined space can be defined by varying amount of both surfactant and solvent
- Successful examples included Fe, Ni and Co particles

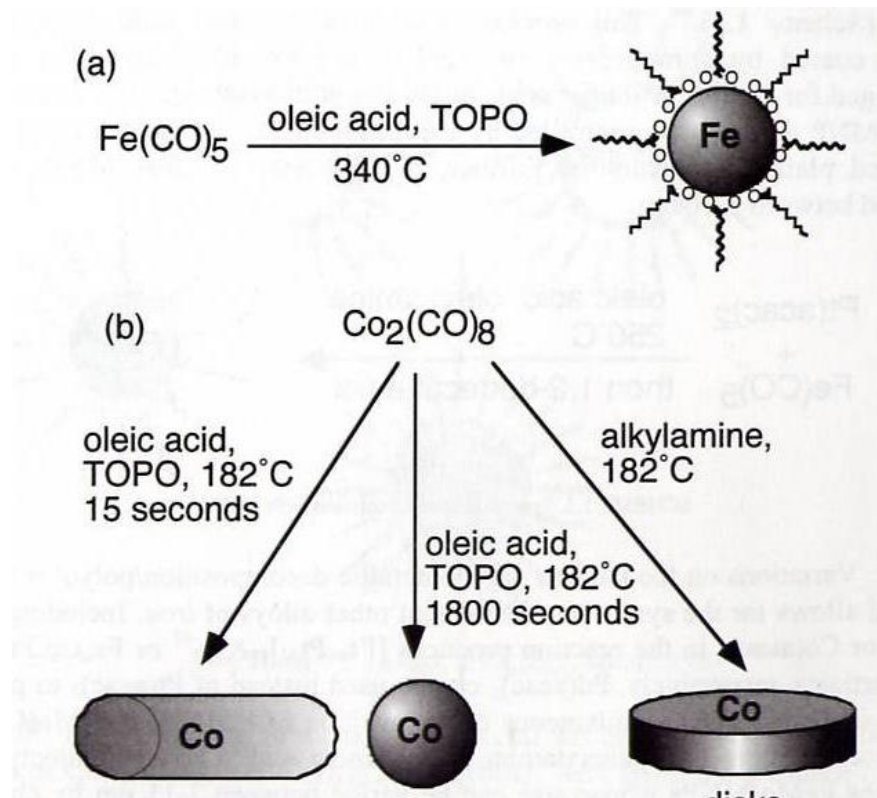


Courtesy from Vincent Rotello, Nanoparticles

# Synthesis of Single Metal MNP

## -- Method II: Thermal Decomposition

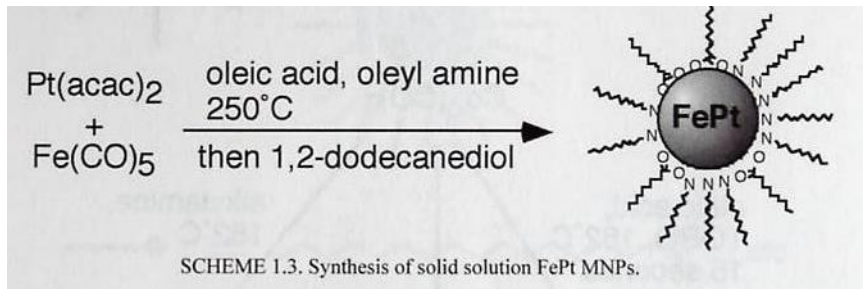
- Thermal Decomposition of organo-metallic complexes can produce highly mono-disperse nano particles.
- Size and dispersity control is attained through high reaction temperature.
- Capping ligands (e.g. Oleic Acid) can also mediate the particle growth by forming a monolayer of nano particles
- Most common precursors: Metal Carbonyl complexes.
- Morphology can also be controlled through various capping ligands



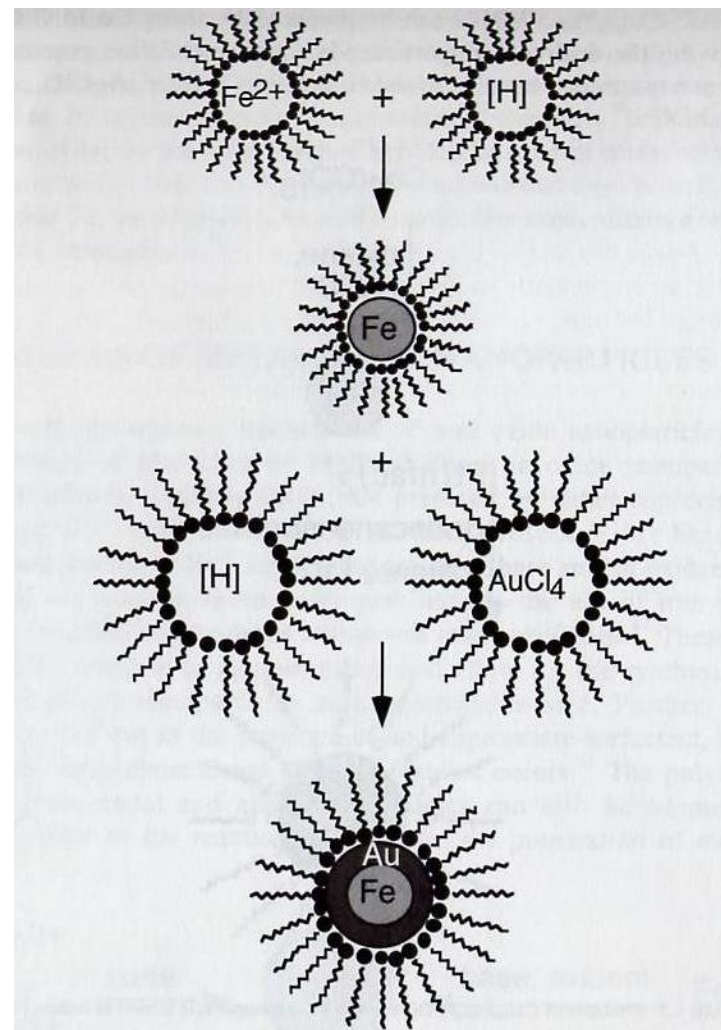
Courtesy from Vincent Rotello, Nanoparticles



# Alloyed Metal Nano Particles

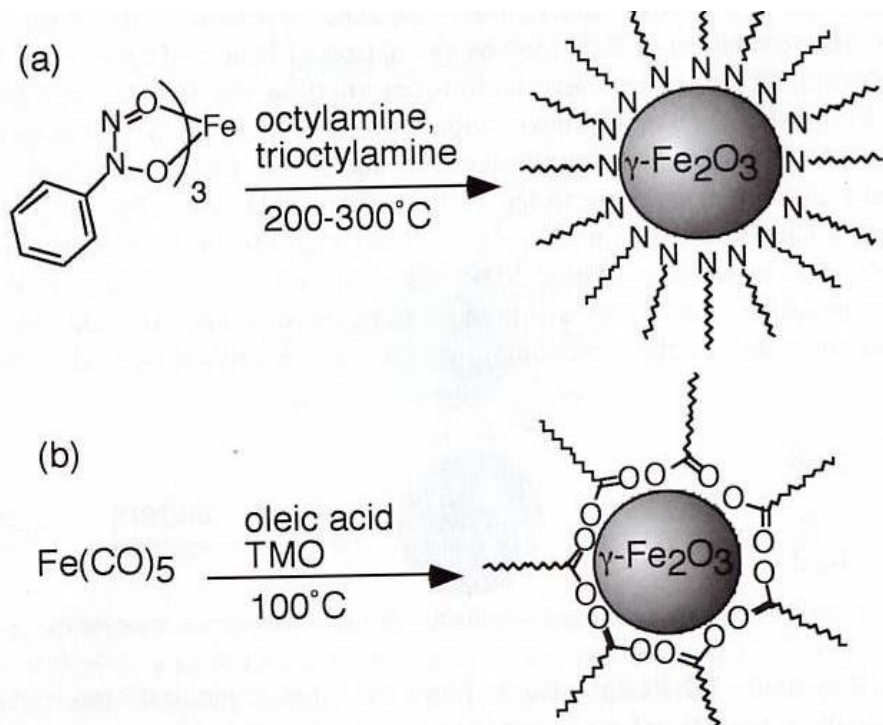


- Solid-solution alloyed metallic nano particles can be attained through simultaneous thermal decomposition
  - Core-shell alloyed nano particles are produced by a stepwise reduction process where each successive step uses larger diameter water droplet to yield the alloyed core-shell particles



Courtesy from Vincent Rotello, Nanoparticles

# Metal Oxide Nano Particles



- Thermal decomposition of metal organic precursors on a hot surface.
- The size of the nano particles can be controlled by reaction temperature and / or the ratios of precursor verse capping ligands