

**College of Science**

**Department of Physics**

**M.Sc. Lectures**

**Semester I**

**Nano-physics**

# **METHODS OF SYNTHESIS TO MAKE NANOPARTICLES**

***REF. INTRODUCTION TO NANOTECHNOLOGY  
BY POOLE, & OWENS***

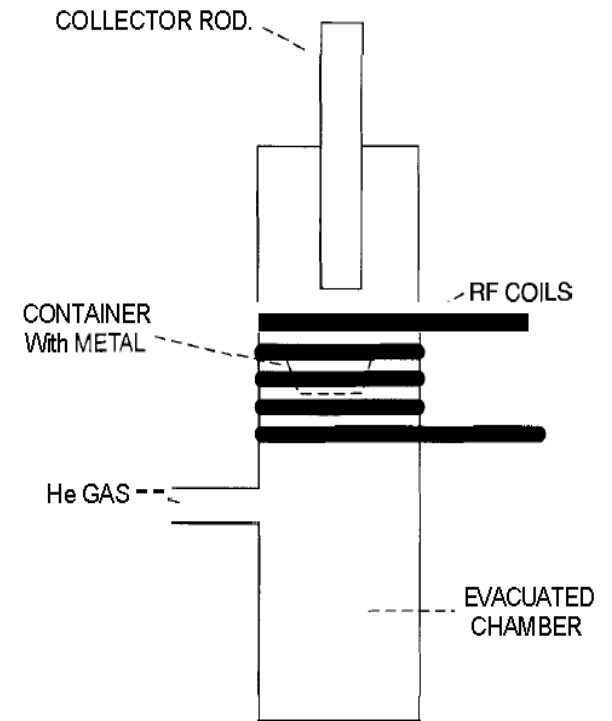
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## RF Plasma

The metal is heated above its evaporation point using high voltage RF coils wrapped around the evacuated system ) in the vicinity of the pestle بودقة حول.

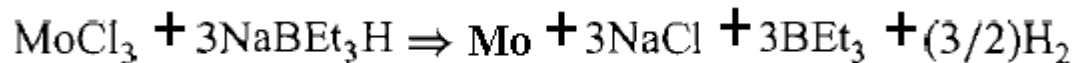
Helium gas is then allowed to enter the system, forming a high temperature plasma in the region of the coils.

The metal vapor nucleates تتكون نوى بخار المعدن on the He gas atoms and diffuses up to a colder collector rod where nanoparticles are formed. The particles are generally passivated يتخمد by the introduction of some gas such as oxygen.



# Chemical Methods

- \* There are a number of different chemical methods that can be used to make nanoparticles of metals,
- \* For example, nanoparticles of molybdenum (Mo) can be reduced in toluene solution محلول التلوين with  $\text{NaBEt}_3\text{H}$  at room temperature, providing a high yield of Mo nanoparticles having dimensions of 1-5 nm.
- \* The equation for the reaction is,



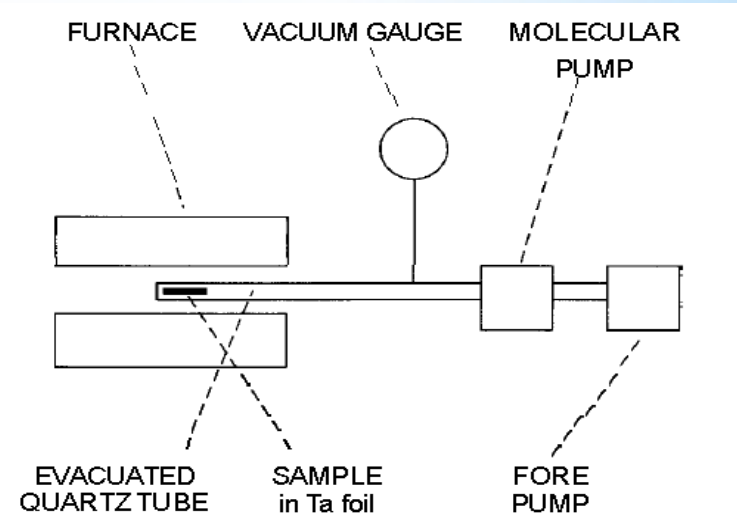
## Thermolysis

Nanoparticles can be made by decomposing solids at high temperature having metal cations, and molecular anions or metal organic compounds. The process is called (Thermolysis).

The material is placed in an evacuated quartz tube and heated to  $400^{\circ}\text{C}$  in the apparatus . At about  $370^{\circ}\text{C}$  the  $\text{LiN}_3$  decomposes, releasing  $\text{N}_2$  gas, which is observed by an increase in the pressure on the vacuum gauge.

In a few minutes the pressure drops back to its original low value, indicating that all the  $\text{N}_2$  has been removed.

The remaining lithium atoms coalesce to form small colloidal رغوية metal particles. Particles less than 5 nm can be made by this method.



## Pulsed Laser Methods

Pulsed lasers have been used in the synthesis of nanoparticles of silver. Silver nitrate solution and a reducing agent are flowed through a blenderlike خلاط device.

In the blender there is a solid disk, which rotates in the solution.

The solid disk is subjected ل يخضع to pulses from a laser beam creating hot spots on the surface of the disk. Silver nitrate and the reducing agent عامل مختزل react at these hot spots, resulting in the formation of small silver particles, which can be separated from the solution using a centrifuge.

The size of the particles is controlled by the energy of the laser and the rotation speed of the disk.

This method is capable of a high rate of production of 2-3 g/min.

