Preparation of Crystalline Gold Nanoparticles and their Prospects in Enhancement of Solar Energy Conversion Efficiency

By

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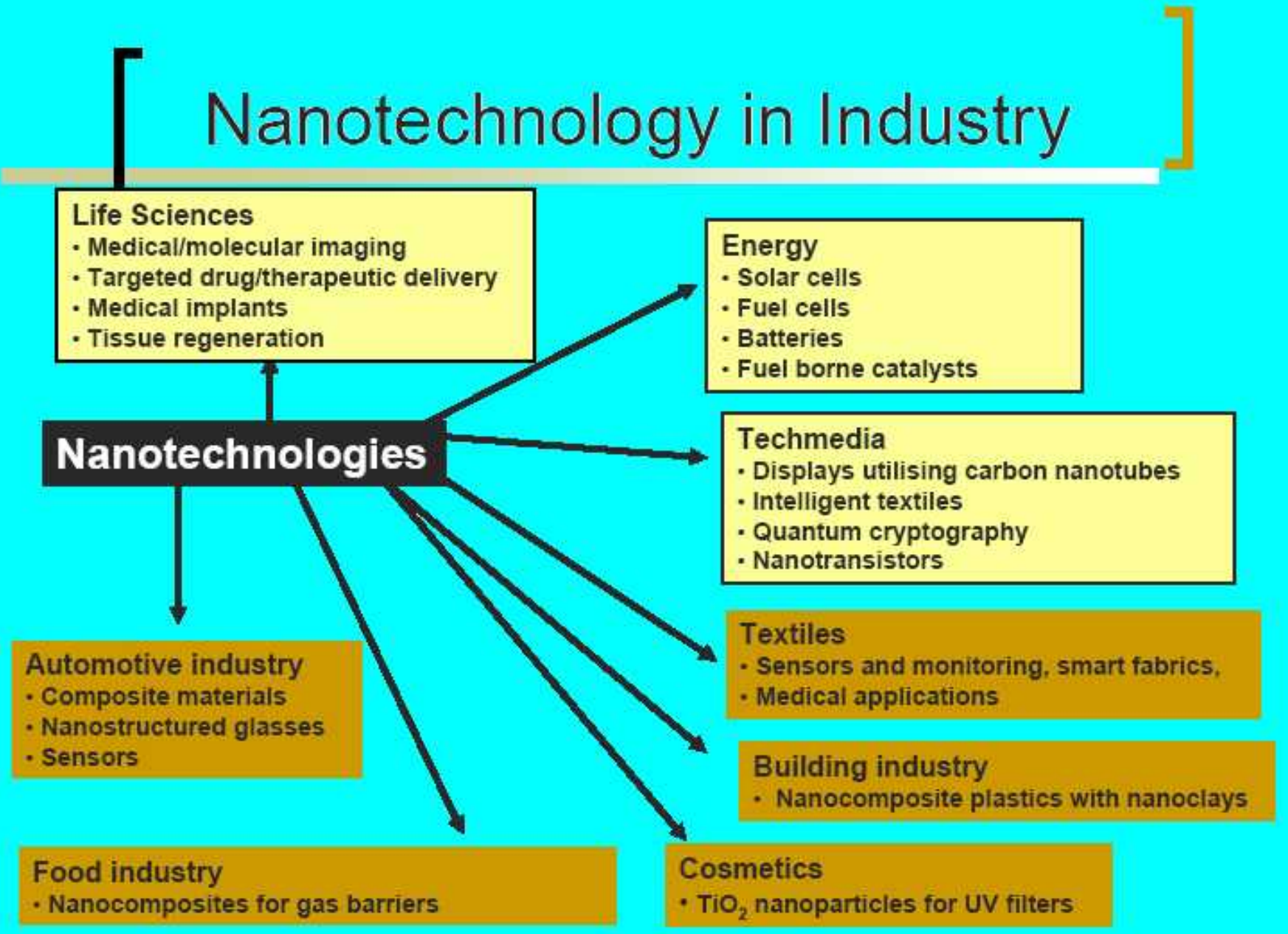
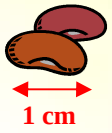
Nanotechnology in Industry



How small is a nanometer? (and other small sizes)

Start with a centimeter.



A centimeter is about the size of a bean.

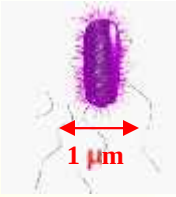
Now divide it into 10 equal parts.

Each part is a millimeter long. About the size of a flea.

Now divide that into 10 equal parts.

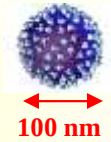
Each part is 100 micrometers long. About the size (width) of a human hair.

Now divide that into 100 equal parts.



Each part is a micrometer long. About the size of a bacterium.

Now divide that into 10 equal parts.

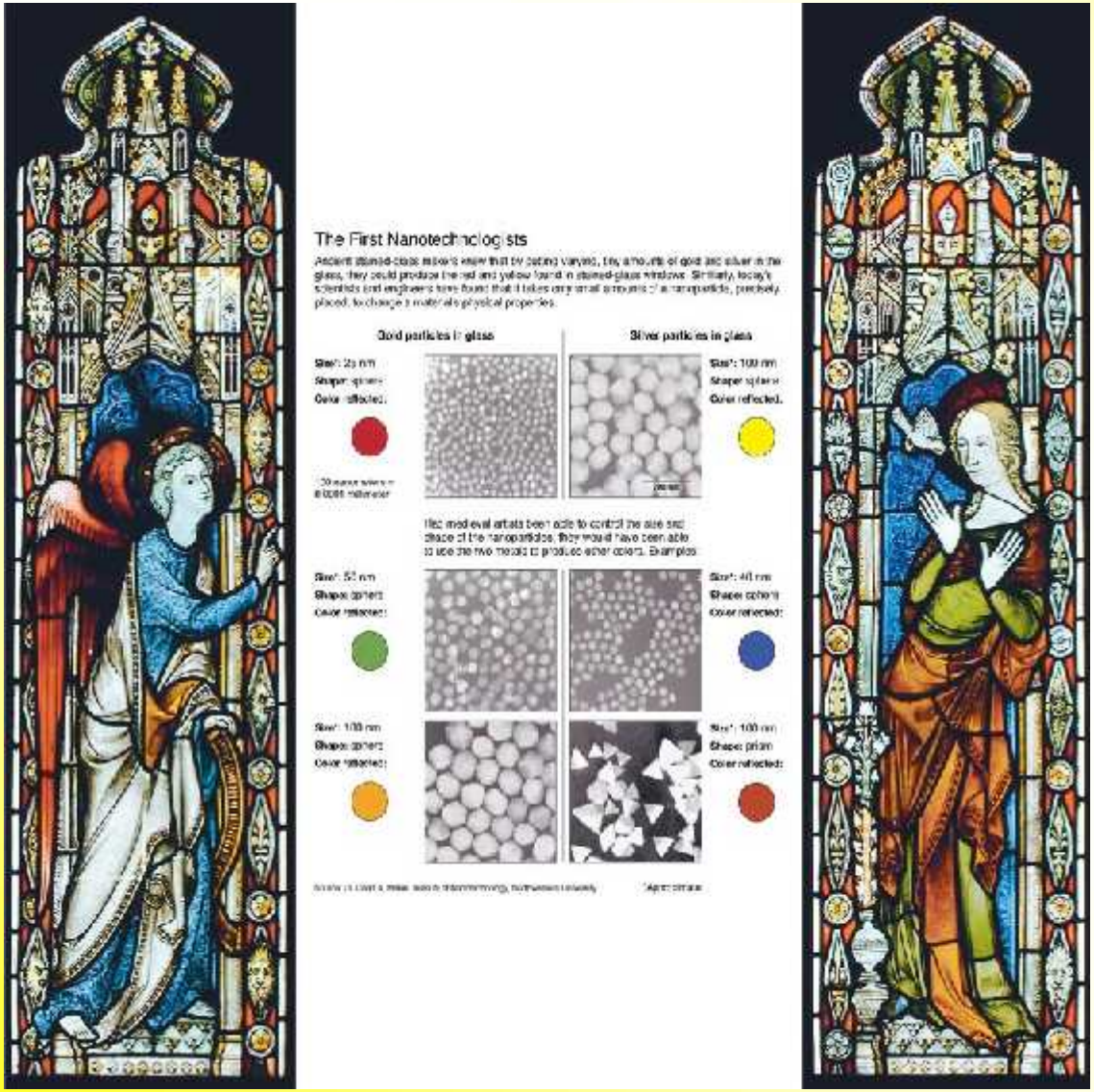


Each part is a 100 nanometers long. About the size of a virus.

Finally divide that into 100 equal parts.

Each part is a nanometer. About the size of a few atoms or a small molecule.

History of gold nanoparticles (GNPs)



GNPs in glass

25 nm — red reflected

50 nm — green reflected

100 nm — orange reflected

The Lycurgus Cup

The Lycurgus Cup made by the Romans dates to the fourth century AD. One of the very unusual features of the Cup is its **colour**.

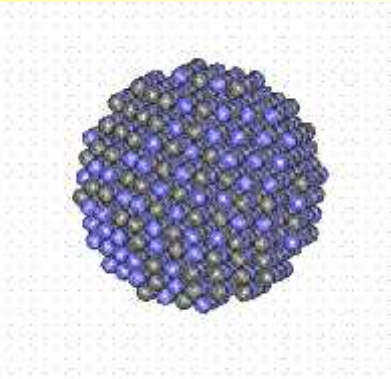
When viewed in reflected light, (in daylight) it appears green.

When a light is shone into the cup and transmitted through the glass, it appears **red**.

Bulk Gold Vs Nanogold

Bulk Gold

- Is shiny
- Always gold in colour
- Is inert
- Conducts electricity



Nanogold

- Vary in appearance depending on size and shape of cluster
- Are never gold in colour
- Are found in a range of colours
- Are very good catalysts
- Are not “metals” but are semiconductors.

Nanotechnology

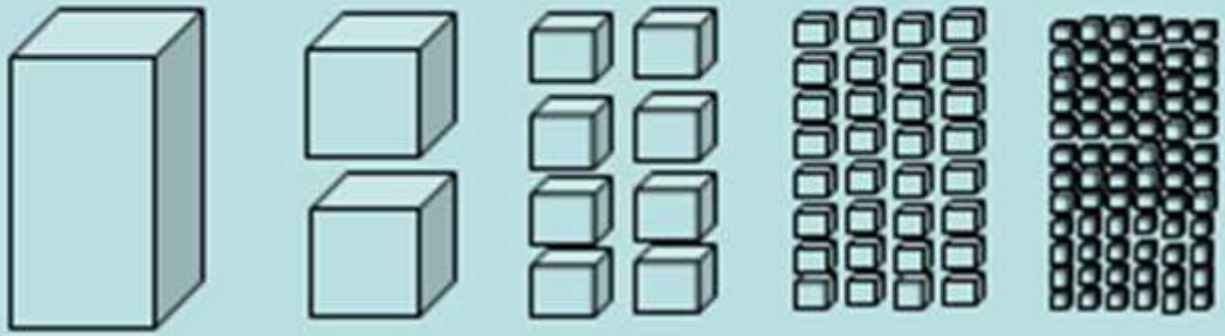
Size

Bulk Gold = Yellow

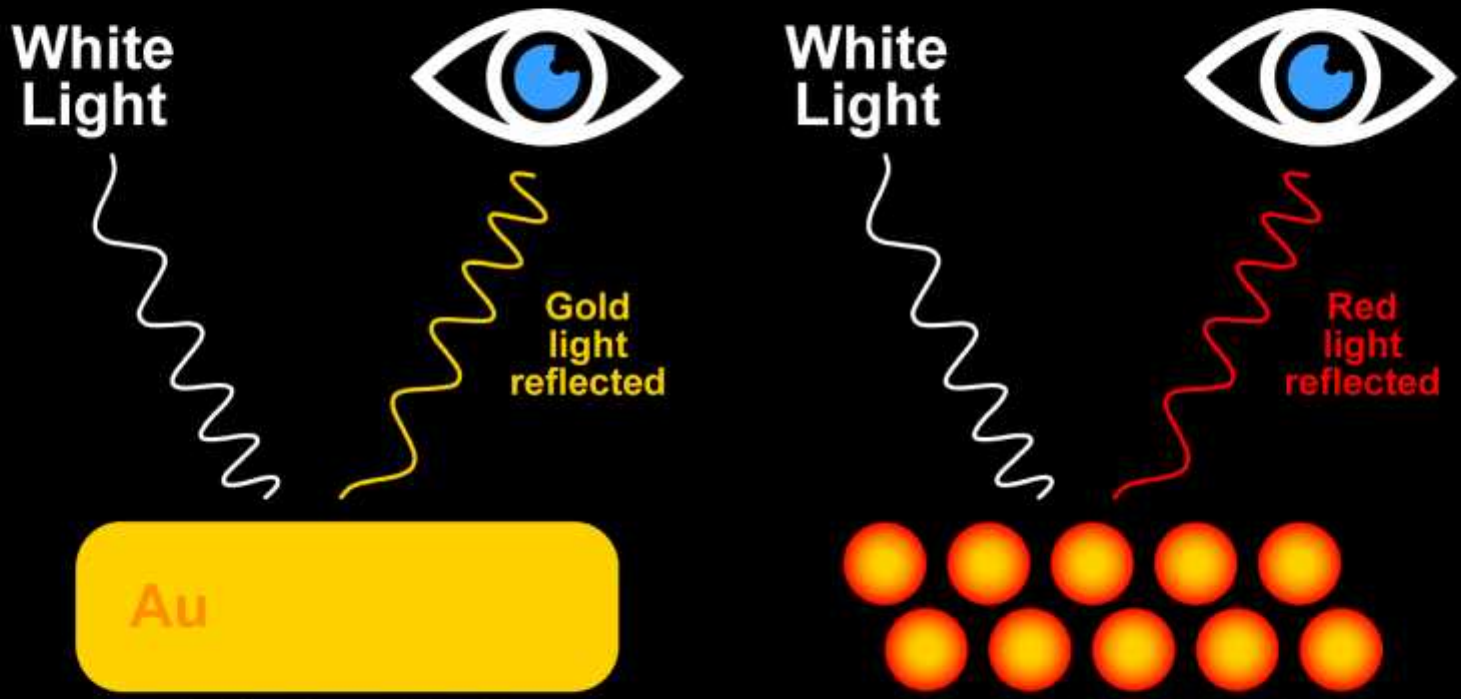
Nanogold = Red

Numbers

Surface Area (S/V)

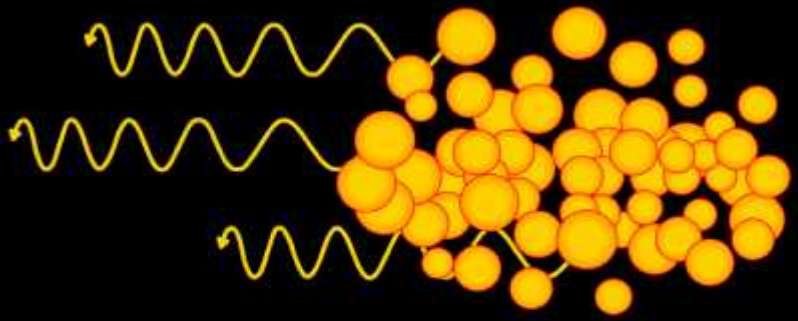


Bulk & Nano


White Light
Gold light reflected
Au
White Light
Red light reflected

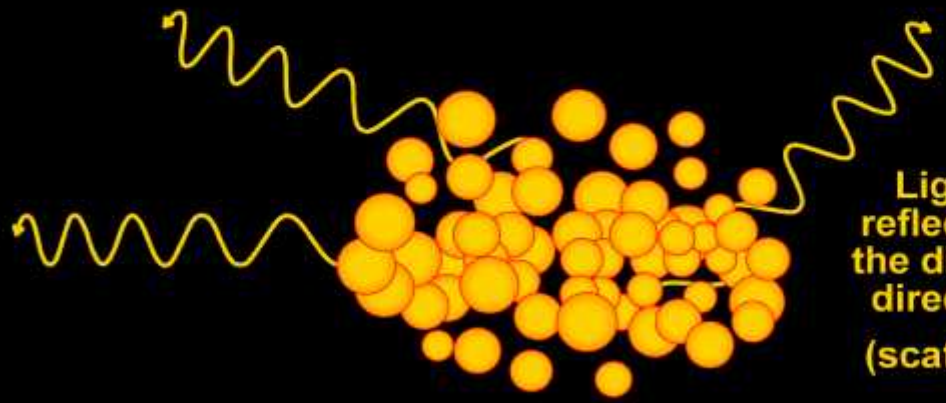
Reflection Of Light

Bulk Au



All light is reflected in the same direction

Nano Au

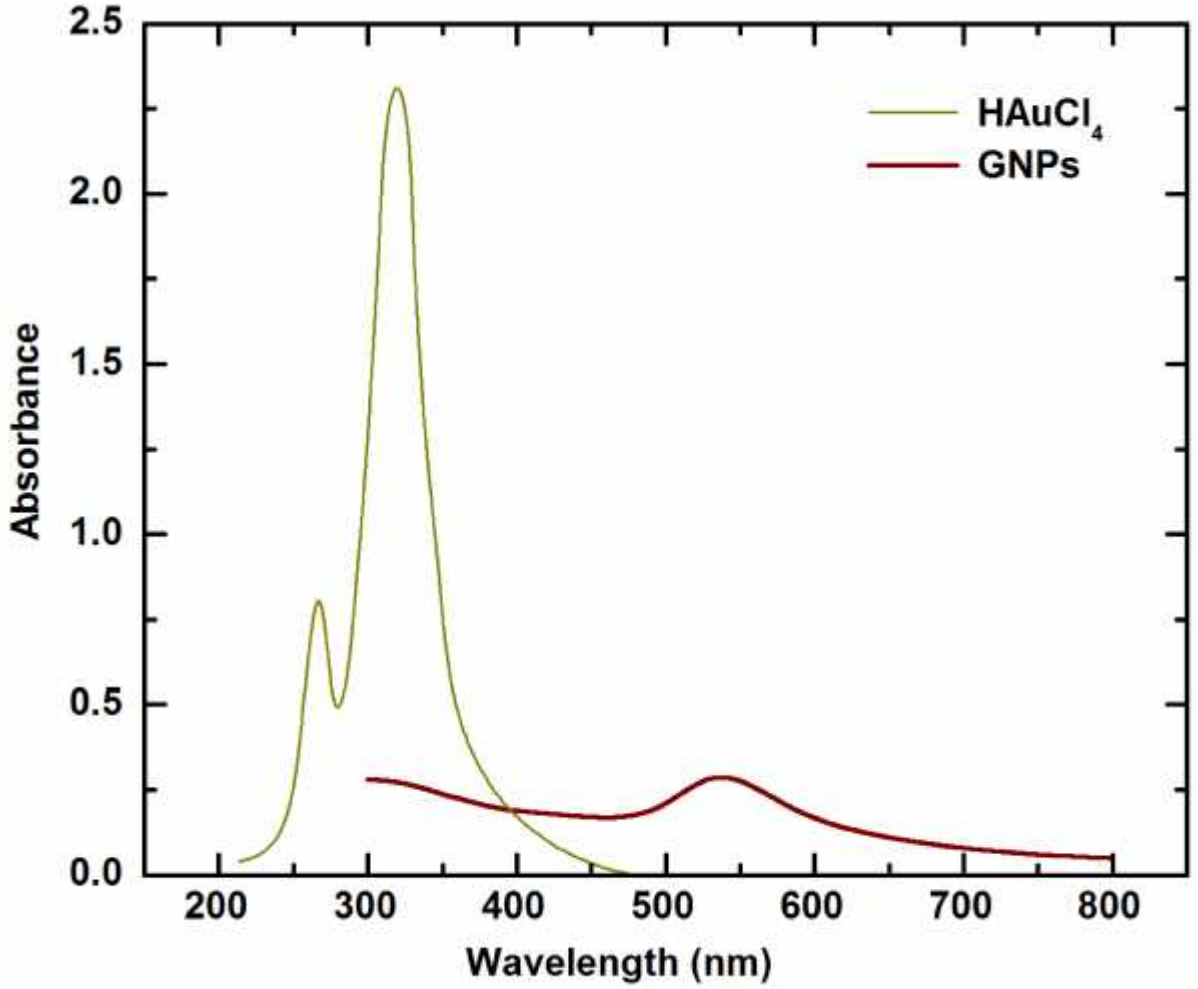


Light is reflected in the different directions

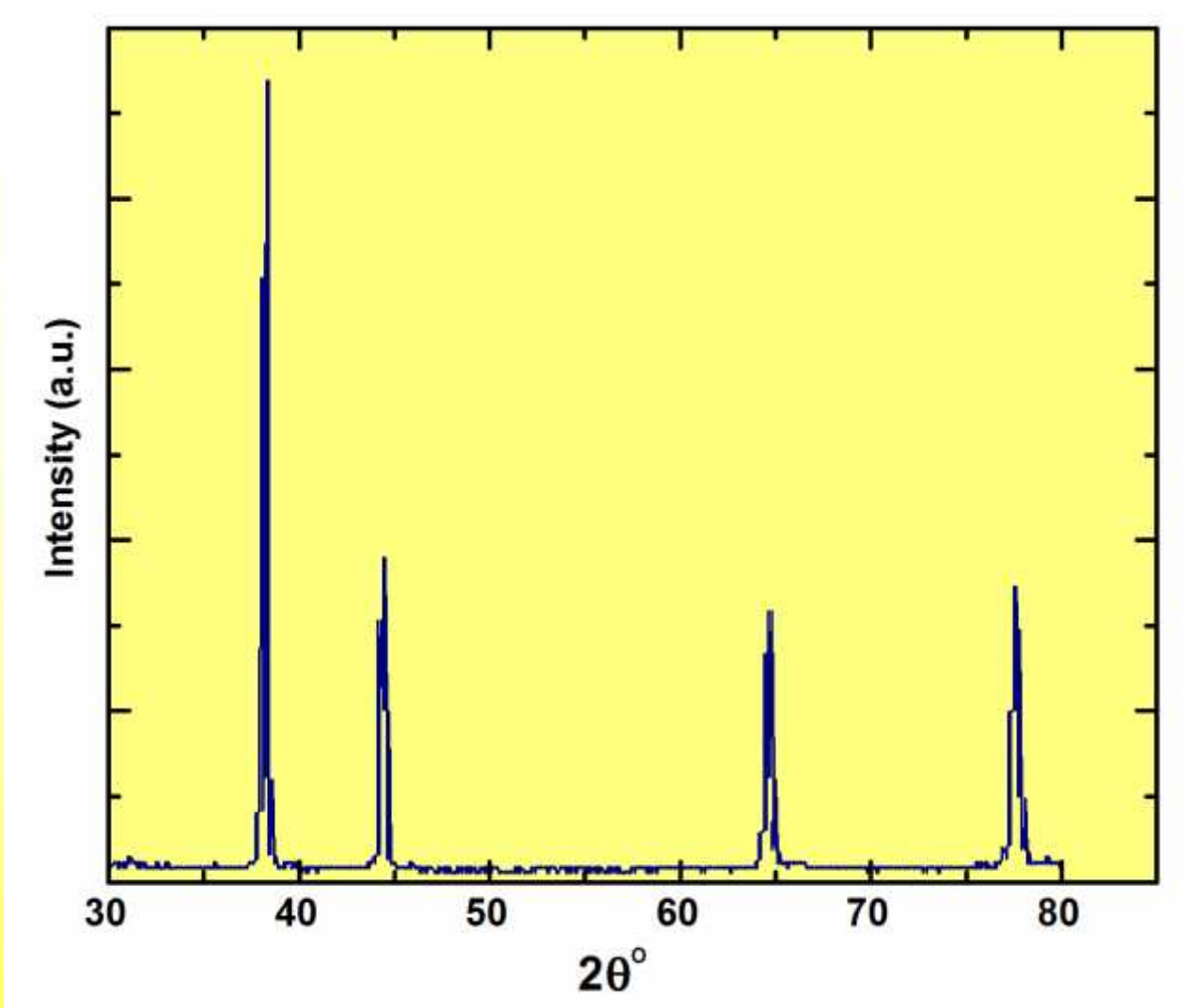
(scattered)

Size & Shape Determines Colour of GNPs

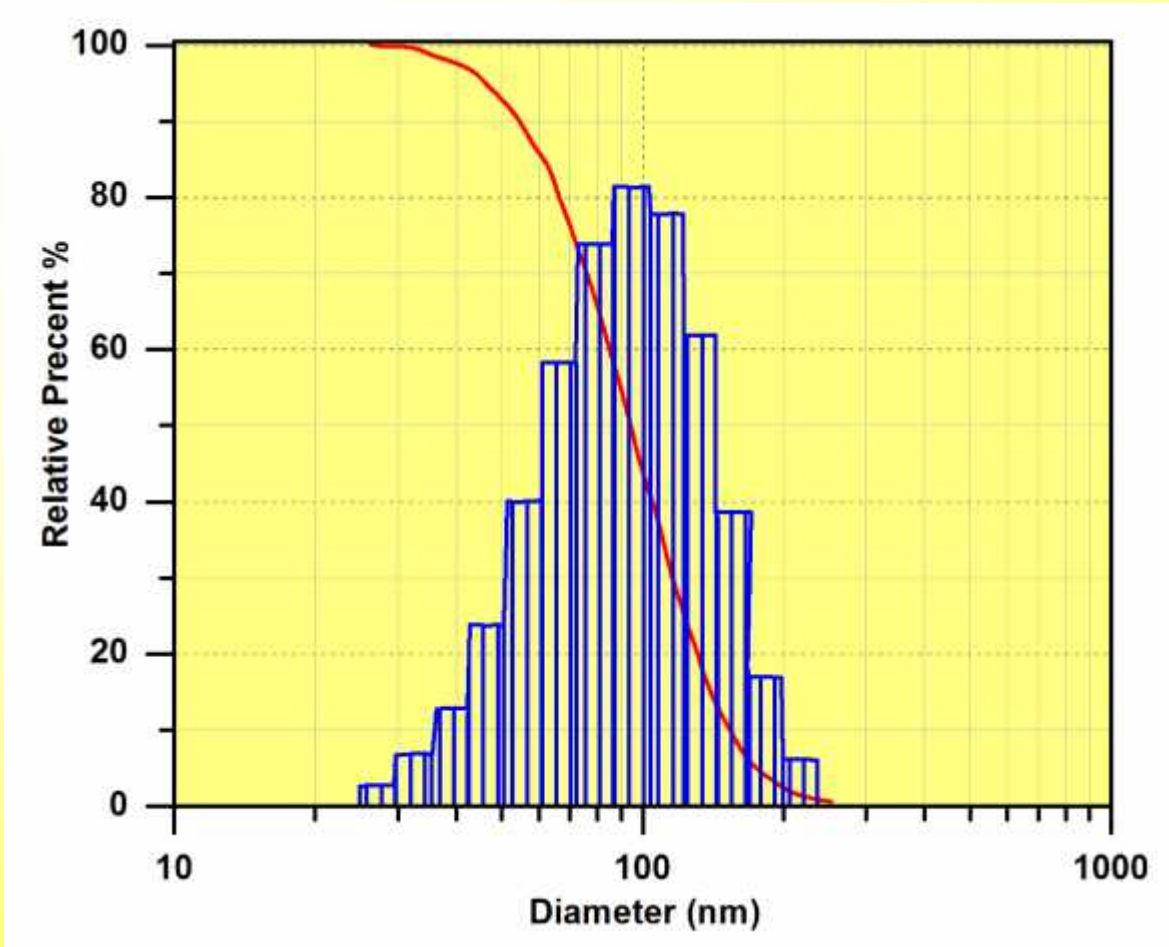
Confirmation of the formation gold nanoparticles (GNPs) by UV-vis absorption spectroscopy



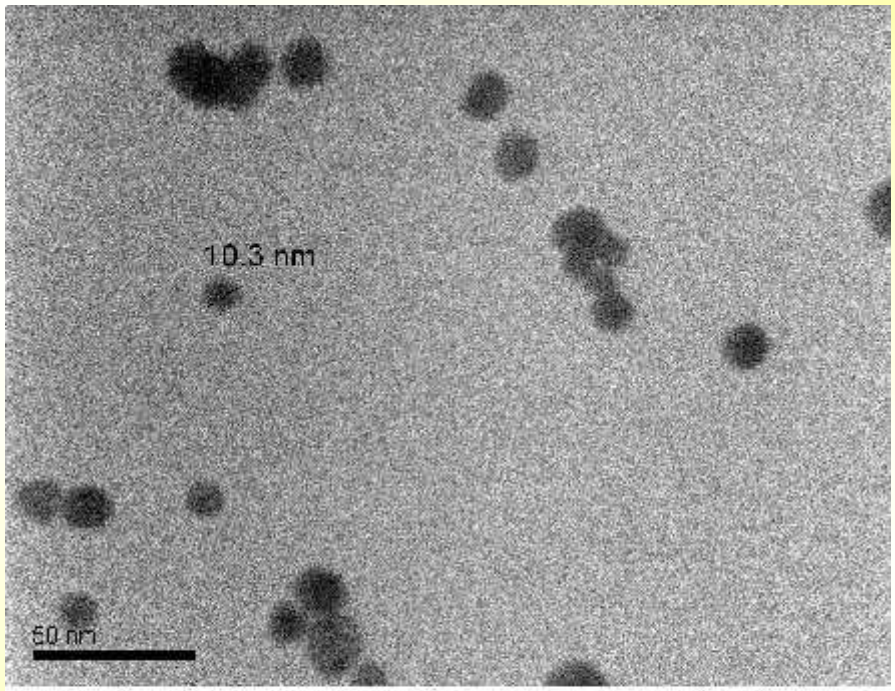
X-ray diffraction (XRD) spectra of gold nanoparticles (GNPs).



Size distribution of colloidal GNPs.



TEM of GNPs confirms their spherical shape



Operator : central lab _Majdh

Voltage : 100 kV

Microscope Name : 10[illegible]_JEOL

Resolution : 1344 x 1036 pixels

Image Notes :

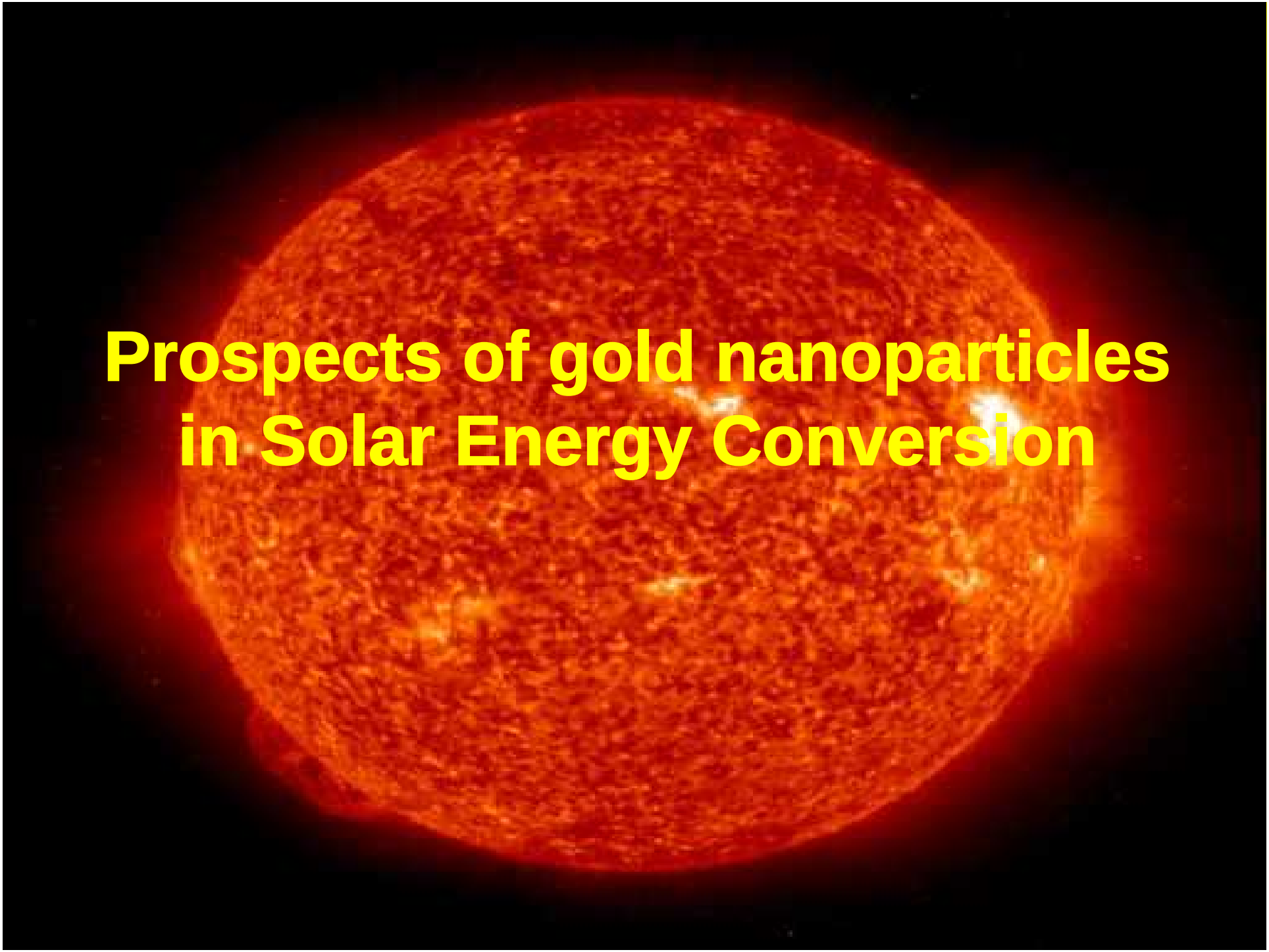
Image Name : gold n,16

Acquisition Date : 2/10/2009

Acquisition Time : 10:03:42 AM

Indicated Magnification : X200000

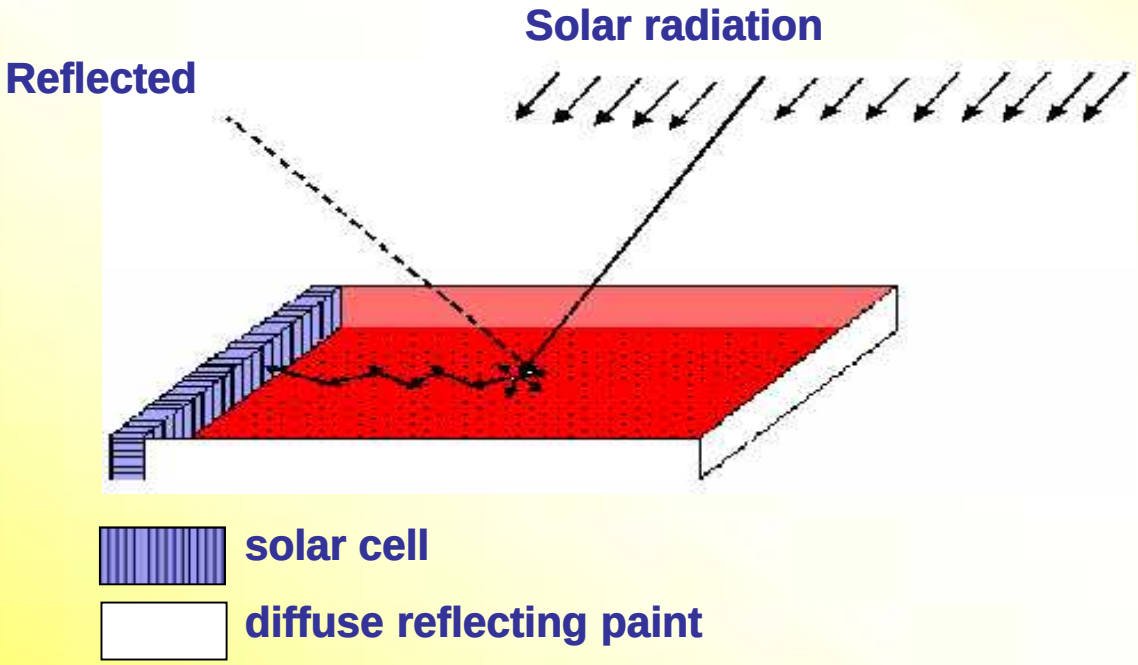
Total Magnification : X710000


Prospects of gold nanoparticles
in Solar Energy Conversion

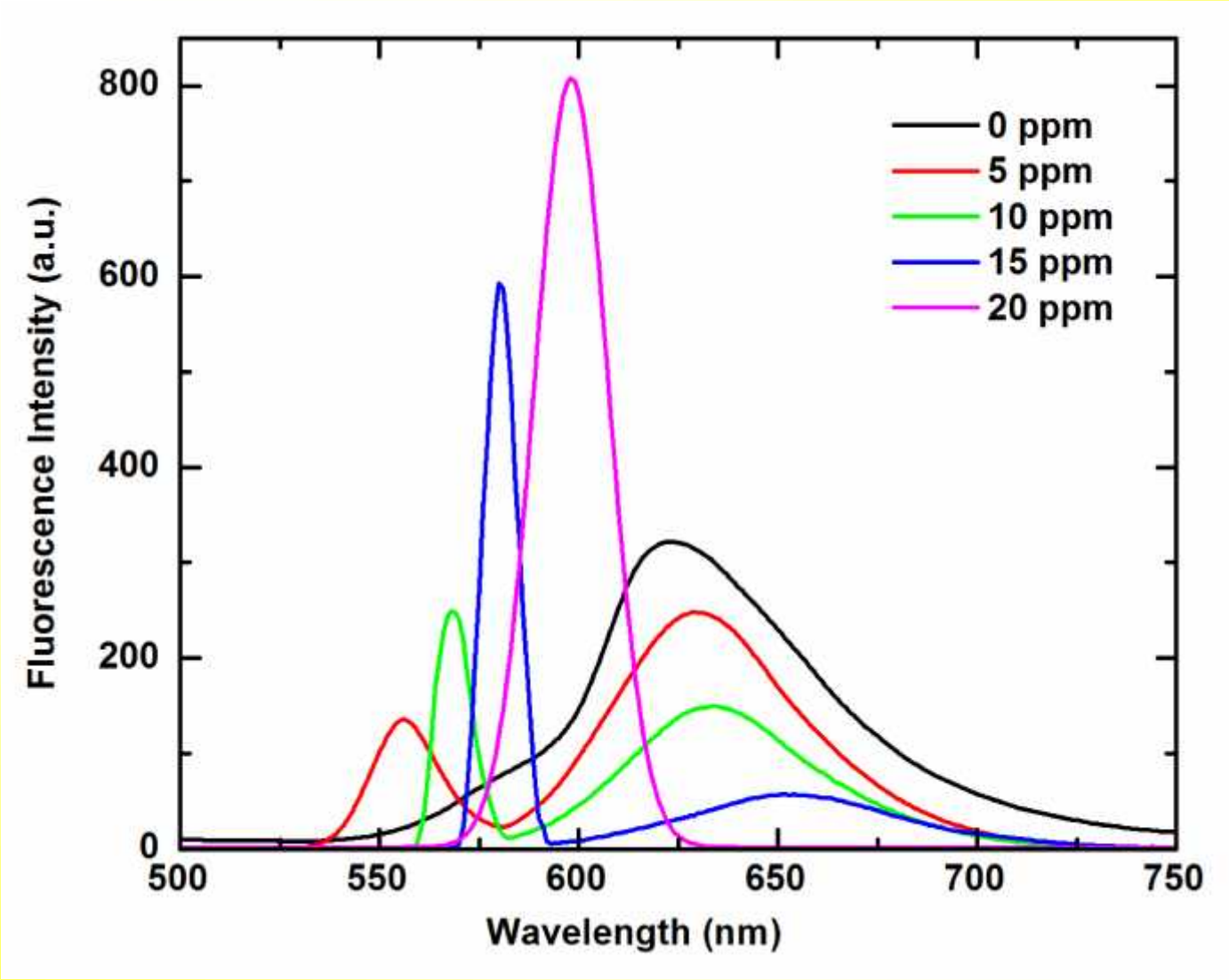
- ***Fluorescent Solar Concentrator (FSC)*** **was proposed. It was consisting of a transparent sheet doped with appropriate fluorescent species.**

- **Sunlight *absorbed* by the dye is then emitted isotropically and trapped in the sheet by *total internal reflection.***

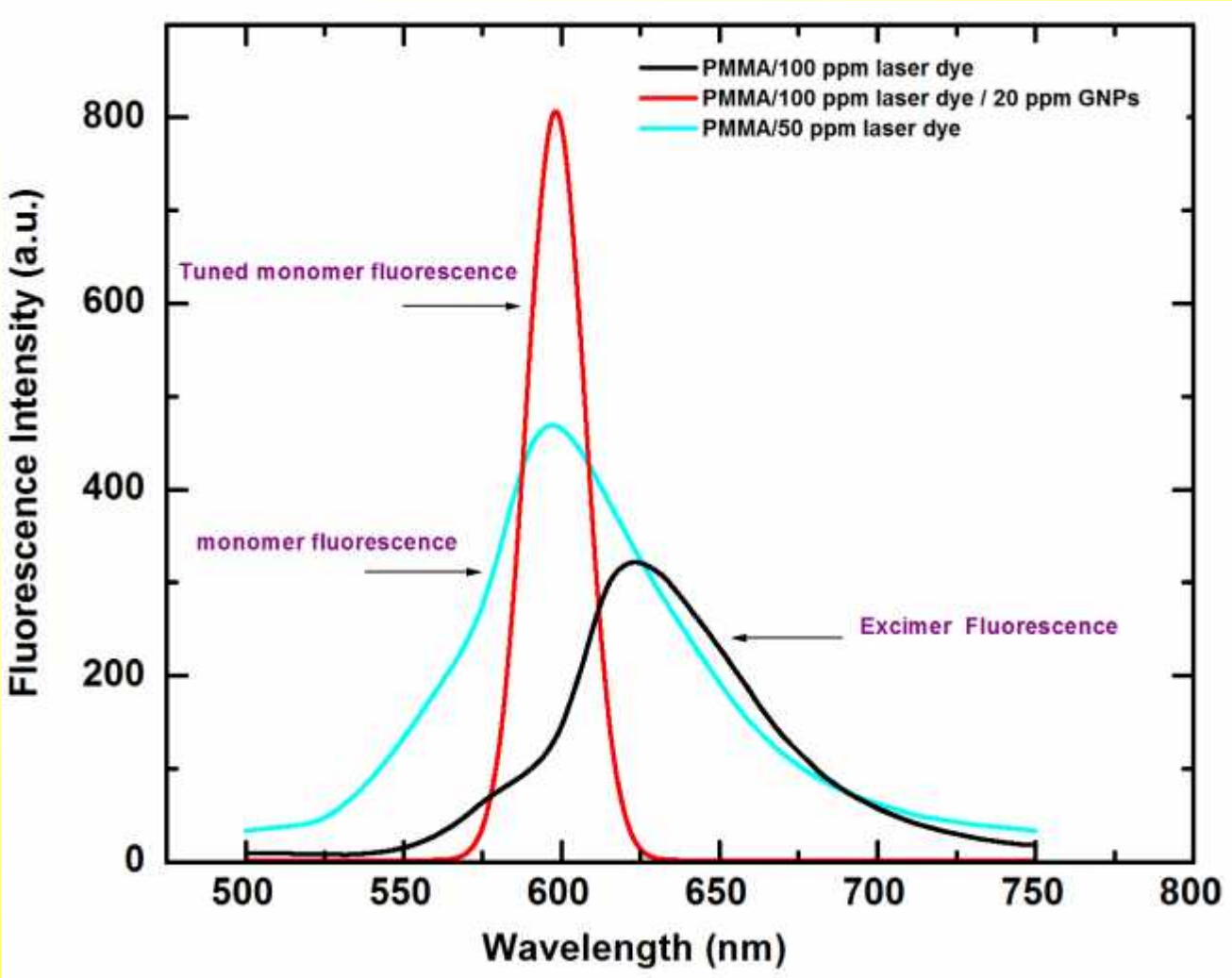
- **Trapped light is converted at the edge of the sheet by a solar cell with *band- gap just less than the luminescent energy.***



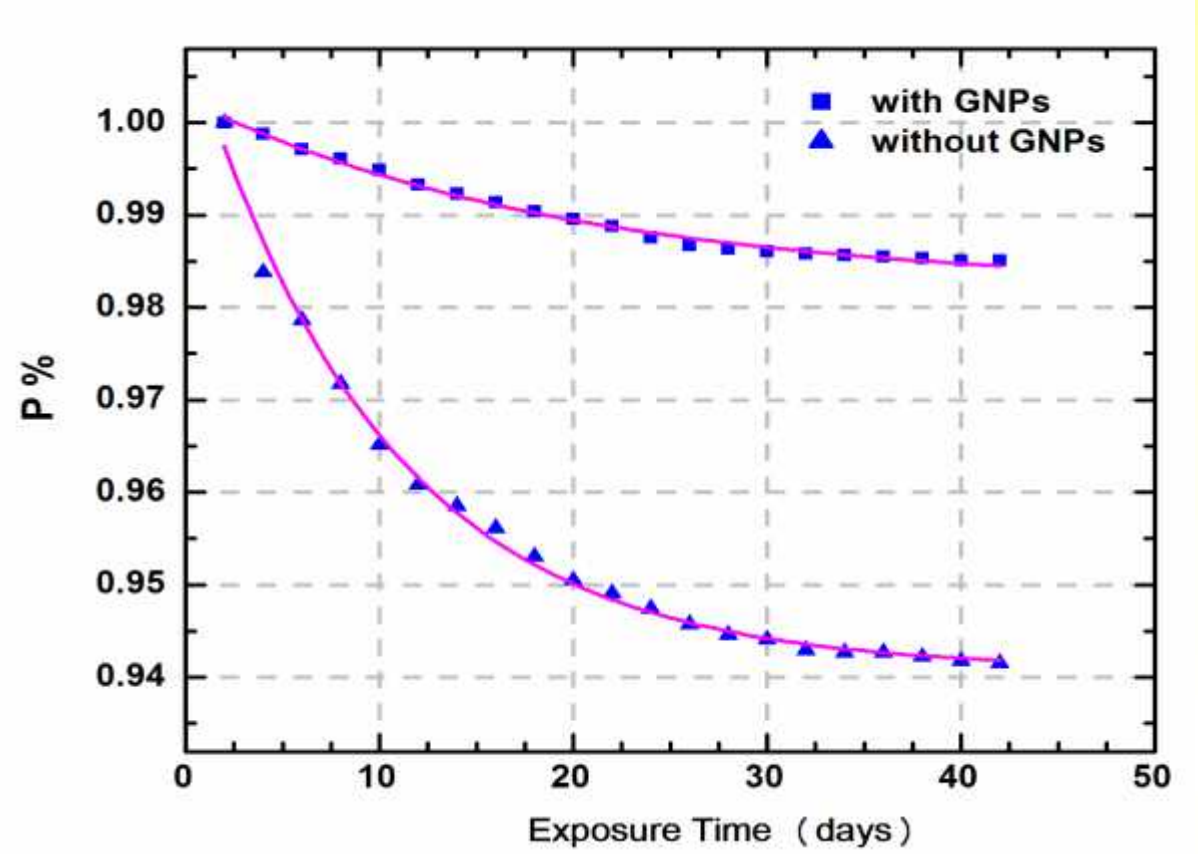
Effect of GNPs concentration on the fluorescence spectra of (PMMA/ 100 ppm MACROLEX Fluorescent Red G) film.



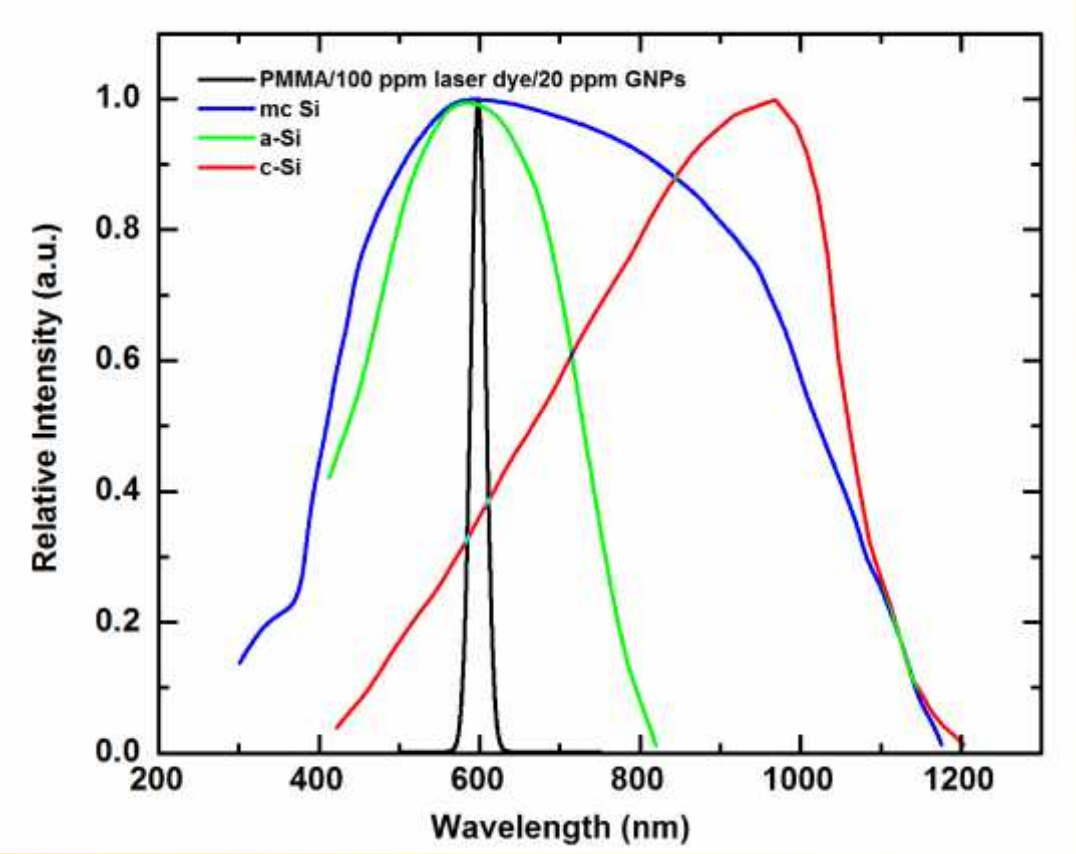
Metal Enhanced Fluorescence (MEF)



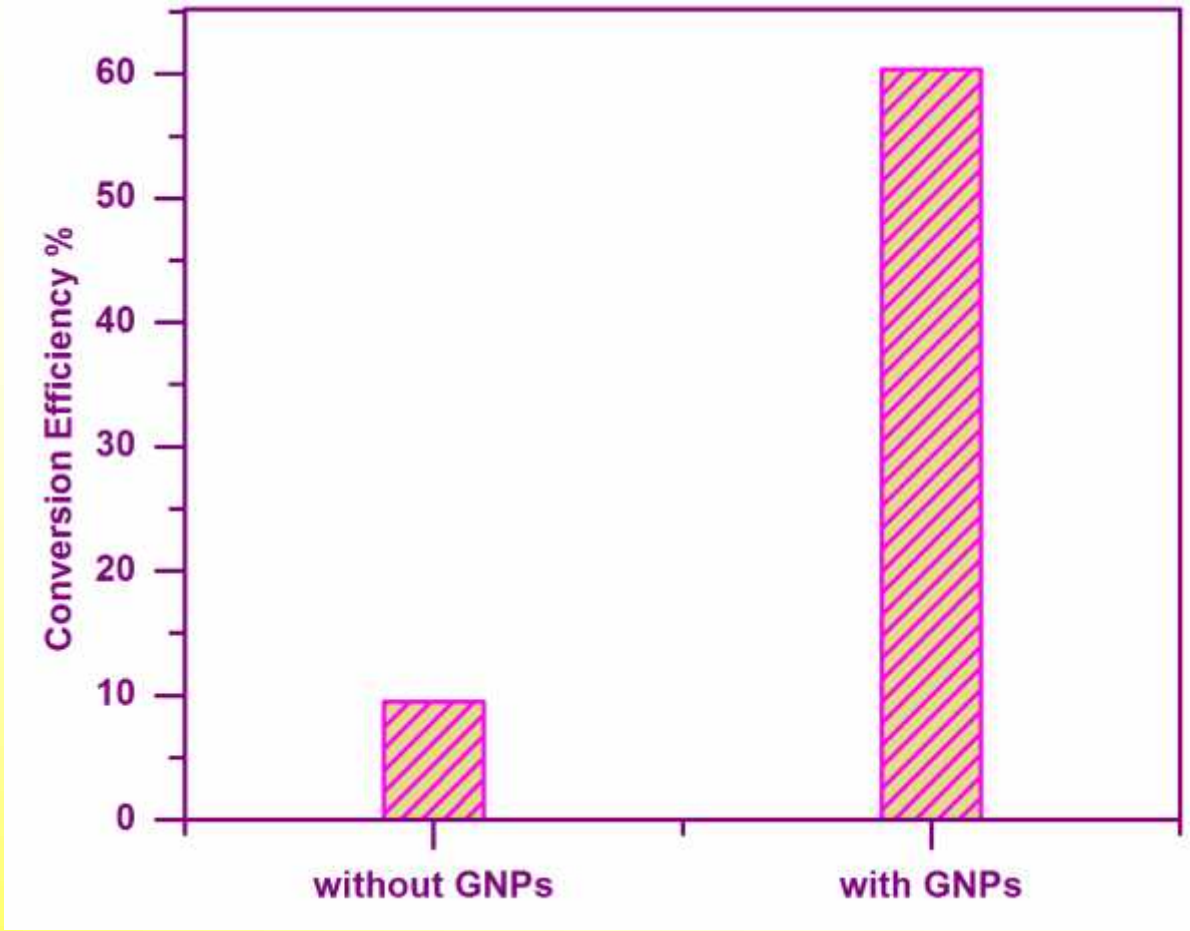
Enhanced Photostabilty of Fluorescent Solar Concentrators by GNPs



The tuned monomer fluorescence spectra of (PMMA/ 20 ppm GNPs/100 ppm MACROLEX Fluorescent Red G) nanocomposite film, compared to the spectral response of silicon solar cells: amorphous (a-Si); multicrystalline (mc-Si); crystalline (c-Si).



Enhanced Conversion Efficiency of Fluorescent Solar Concentrators by GNPs



Conclusions

- This paper reports on the enhancement of excimer fluorescence of a coumarin derivative molecules (MACROLEX Fluorescent Red G), by using GNPs in PMMA.

- We explained the fluorescence enhancement factor on the basis of localized surface plasmon resonance (LSPR) spectra of gold nanoparticles.

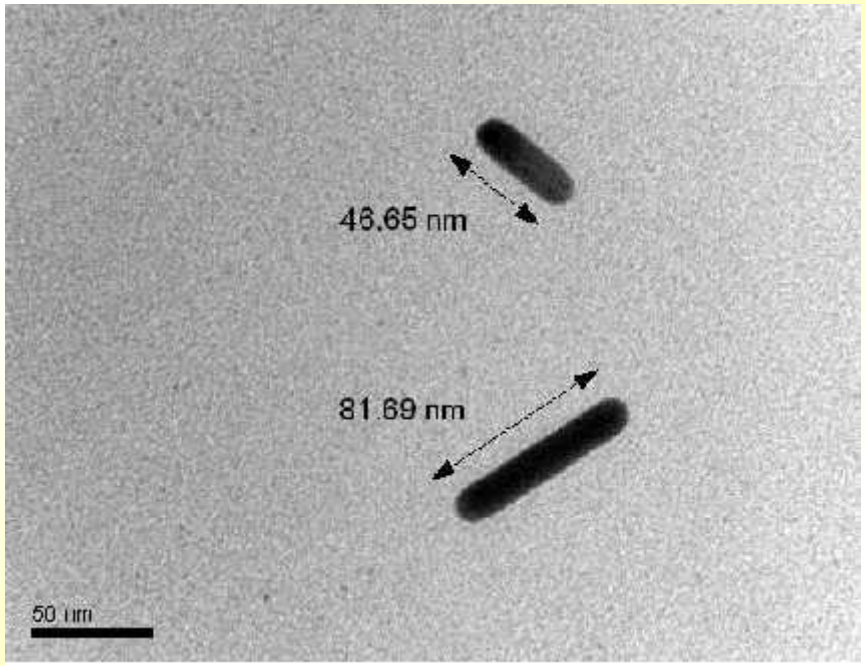
- PMMA/GNPs nanocomposite has a superior advantage that it can be overloaded with high laser dye concentrations, without the formation of dye dimers which was a great problem due to their weak fluorescence.

- Incorporating GNPs is PMMA/dye matrix, increases the photostability of dye, since the calculated value of dye photodegradation rate is doubled after adding GNPs to PMMA matrix.

- Our results is have incredible impact in enhancing solar energy conversion by commercial photovoltaic cells. This can be achieved by using the the optimized PMMA/GNPs nanocomposite as a fluorescent solar concentrator (FSC) and fluorescent down-shifter (FDS).

Work in Progress

Synthesis of gold nanorods for medical and Energy Applications



Operator : central lab._Majdi

Image Name : nanorods7

Voltage : 100 kV

Acquisition Date : 2/15/2007

Microscope Name : 011_JEOL

Acquisition Time : 11:35 PM

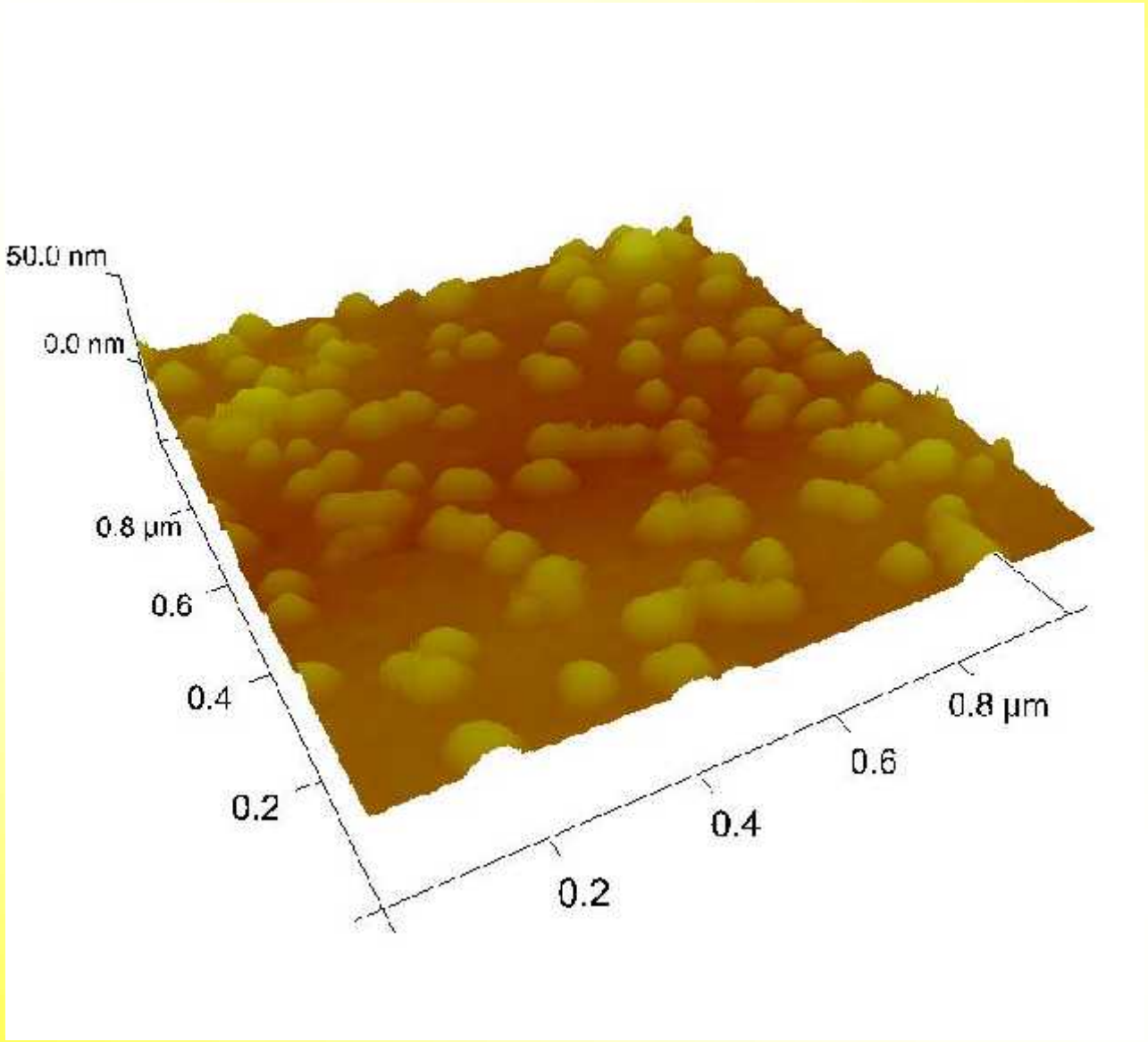
Resolution : 1344 x 1036 pixels

Indicated Magnification : X400000

Image Notes

Total Magnification : X540000

AFM of Spherical Nanogold Thin Films




Thanks