Name (Title):
Hisanori Shinohara (Professor)

Affiliation:
Department of Chemistry & Institute for Advanced Research, Nagoya University.

Address:
Furo-cho, Nagoya 464-8602, Japan.

Home Page: http://nano.chem.nagoya-u.ac.jp/

**Lecture Title:**

# Putting Metal Atoms into Fullerenes

**Abstract:**

Fullerenes have spherical empty space inside the carbon cage. The hollow space is quite unique in that it is in nanometer-scale and the volume can be varied with the size of fullerenes. It varies, for example, from 0.4 to 1.0 nm in diameter on going from $C_{60}$ to $C_{240}$ considering the van der Waals radii of carbon (0.17 nm). It is an intuitively natural idea that one can stuff atoms into these empty space inside the fullerenes, since the endohedral doping may alter the molecular and solid state properties of fullerenes.

The existence of endohedral metallofullerenes (fullerenes with metal atom encapsulated)[1] has long been supported both by experiments and by theoretical calculations. The first endohedral metallofullerene synthesized macroscopically was La@$C_{82}$ (La atom encaged by $C_{82}$ fullerenes) in 1991 by Smalley and coworkers[2]. Following the macroscopic production and solvent extraction of La@$C_{82}$, other group 3 metallofullerenes including Y@$C_{82}$ and Sc@$C_{82}$ were produced and extracted from soot. Even the metallofullerenes with two and three metal atoms inside, such as $La_2$@$C_{80}$, $Y_2$@$C_{82}$, $Sc_2$@$C_{84}$, and $Sc_3C_2$@$C_{80}$, have also been produced and extracted from soot in macroscopic quantity. Mixed di-metallofullerenes like LaY@$C_{80}$ was also synthesized. The first purification and isolation by an elaborate liquid chromatography was achieved in 1993 by the present research group. We also reported the first X-ray structural confirmation for endohedral structure of a pure form in 1995.

In this lecture, after briefly reviewing some historical developments of endohedral metallofullerenes, I will discuss the recent progress of science and technology of metallofullerenes in terms of structural and electronic/magnetic properties. Furthermore, I will talk about synthesis, characterization and applications of carbon nanotubes encapsulating these metallofullerenes, a metallofullerenes-nanotubes hybrid materials (the so-called nano-peapods)[3].

References

[1] H.Shinohara, *Rep.Prog.Phys.* 63, 843 (2000).
[2] Y. Chai *et al. J.Phys.Chem.* 95, 7564 (1991).
[3] K.Hirahara *et al. Phys.Rev.Lett.* 85, 5384 (2000).