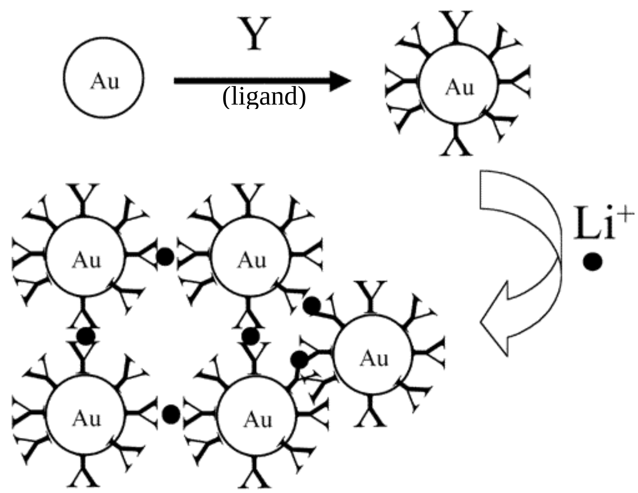
Development of Novel Materials for Optical Sensing and Environmental Remediation Strategies

Sherine O. Obare
Western Michigan University
February 24, 2005

Tailored molecular and nanoscale materials have been developed for (1) optical sensing strategies, and (2) establishing catalytic systems for organohalide remediation.

Optical lithium ion sensors that allow both direct and real-time detection are in demand for medical and industrial applications. Patients suffering from certain neurological disorders consume lithium to treat the illness. In industry, lithium is being developed for use as a power source in lithium ion batteries. A number of strategies were developed in which fluorescent sensor molecules were designed to selectively bind to Li^+ and after binding displayed a change in optical property. These sensor molecules were also used to develop the first fiber-optic lithium ion sensor, which allowed the detection of Li^+ in remote areas.

In another strategy, gold nanoparticles were used to develop a colorimetric method for sensing lithium ions in aqueous environments. Gold nanoparticles display unique optical properties and have extinction coefficients higher than most organic dyes. In this strategy, gold nanoparticles were functionalized with an organic ligand, which selectively bound Li^+ by forming a 2:1 ligand-metal complex. Upon addition of Li^+ to the functionalized gold nanoparticles, the ligands bound to Li^+, induced nanoparticle aggregation. The aggregation resulted in visible color changes, which could be related to the amount of Li^+ present in solution.



Surface functionalization of nanoparticles has also been used to establish a strategy for organohalide degradation. Organohalides are major ground water contaminants and safe methods to degrade them are needed. TiO_2 nanoparticles were functionalized with iron (III) porphyrin Under appropriate conditions, light irradiation into the TiO_2 band gap resulted in electron transfer from the TiO_2 conduction band to iron, and reduced Fe^{III} to Fe^{II}. Fe^{II} reacted with many organohalides in the dark and was oxidized back to Fe^{III}. This method provides a new example of solid-state materials for environmental remediation.

Selected References

1. Obare, S. O. ; Ito, T.; Balfour, M. H.; Meyer, G. J. *Nano Lett*. **2003**, *8*, 1151.
2. Busbee, B. D.; Obare, S. O.; Murphy, C. J. *Adv. Mater.* **2003**, *15*, 414.
3. Obare, S. O.; Hollowell, R. E.; Murphy, C. J. *Langmuir* **2002**, *18*, 10407.
4. Obare, S. O.; Murphy, C. J. *Inorg. Chem*. **2001**, *40*, 6080.
5. Obare, S. O.; Murphy, C. J. *New J. Chem*. **2001**, *25*, 1600.