METAL NANOPARTICLE AND GRAPHENE-METAL NANOPARTICLE COMPOSITES: CHARGE TRANSFER AND SURFACE INTERACTIONS WITH TARGET MOLECULES

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INTRODUCTION

Nanostructured materials offer possible solutions to meet the world's increasing energy demands[1] as well as the problem of sensing trace molecular species.[2-3] Graphene and metal nanoparticle (GM) composites possess properties which are attractive for sensing, photocatalysis, and photo-energy conversion. Along with simple methods for producing GM materials, an understanding of interactions between molecular species and GM is key to device implementation. GM materials are produced via simple chemical methods. Adsorption and complexation of molecular species with GM material leads to new electronic properties and allows for strong molecule-GM interaction. Photoinduced interactions between GM composites and adsorbed molecular species include electron transfer which is important for energy conversion and catalytic processes.

EXPERIMENTAL

Silver nanoparticles and GM composites are synthesized via chemical methods. Materials are characterized using scanning electron microscopy and transmission electron microscopy. Interaction of nanoparticles and GM composite with target organic molecules is probed with spectroscopic methods: Raman, UV-visible absorption, fluorescence, ultrafast transient absorption, and fluorescence upconversion.

RESULTS

We have studied interaction between conjugated organic molecules and silver nanoparticles[4] along with graphene-silver nanoparticle composite. Charge-transfer complexation and excited state electron transfer between amine-functionalized porphyrin and silver nanoparticles is studied using absorption, Raman, transient absorption, and fluorescence upconversion spectroscopies. This study highlights the importance of porphyrin functional substituents for facilitating interaction with silver nanoparticles. Single to few-layer graphene oxide (GO) films with silver nanoparticles on the surface are employed are employed as a surface enhanced Raman (SERS) substrate for chemical sensing. In one study, illumination controlled growth of silver nanoparticles is used to create SERS active films capable of low nM SERS sensing.[3] Graphene oxide-silver nanoparticle composite is shown to enhance SERS sensitivity for molecules which complex with GO. This highlights the usefulness of GO for concentrating and adsorbing targeted molecular species. The capability of graphene oxide-silver nanoparticle films to sense molecules considered environmental contaminants is currently being investigated. An additional benefit of these films is their potential to facilitate photocatalytic degradation of contaminant molecules using UV-light.

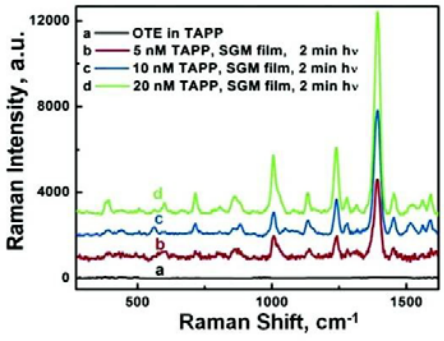

Figure 1: SERRS spectra of tetra(4-aminophenyl) porphyrin in nanomolar concentrations acquired using titanium dioxide/graphene/silver nanoparticle (SGM) film. Reprinted with permission from {*J. Phys. Chem. Lett*, **2012**, 1453-1458}. Copyright {2012} American Chemical Society.

ACKNOWLEDGEMENTS

The research described herein was supported by the Division of Chemical Sciences, Geosciences and Biosciences, Basic Energy Sciences, Office of Science, United States Department of Energy through grant number DE-FC02-04ER15533.

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