Investigation of the Photophysics of Gadolinium Doped WO_{3-x}

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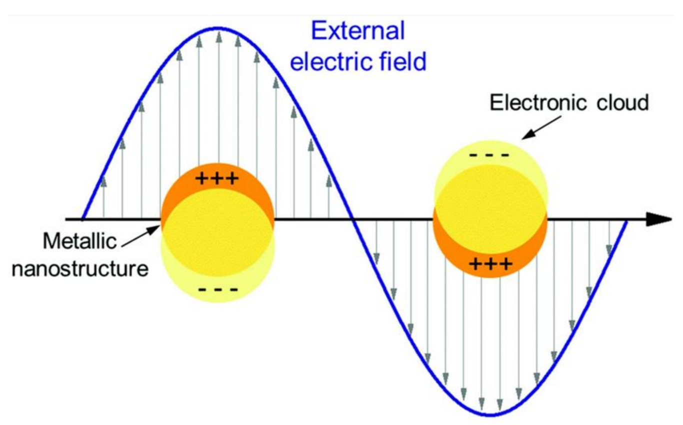
Introduction



Plasmonic materials are present in almost every field of science, from electronics to medicine. Plasmonic materials are unique in that they have an electrochemical response when exposed to a specific frequency of light, making plasmonic semiconductors extremely promising in the fields of photocatalysis and electrochromics. Our group decided to analyze gadolinium-doped defect tungsten oxide in different percentages. Our working assumption is that with the addition of gadolinium, we can alter the wavelength location of the plasmon and alter the photophysics of the nanoparticles, opening the door for a wider range of applications of relatively easily-accessible materials.

Nanoparticle Synthesis

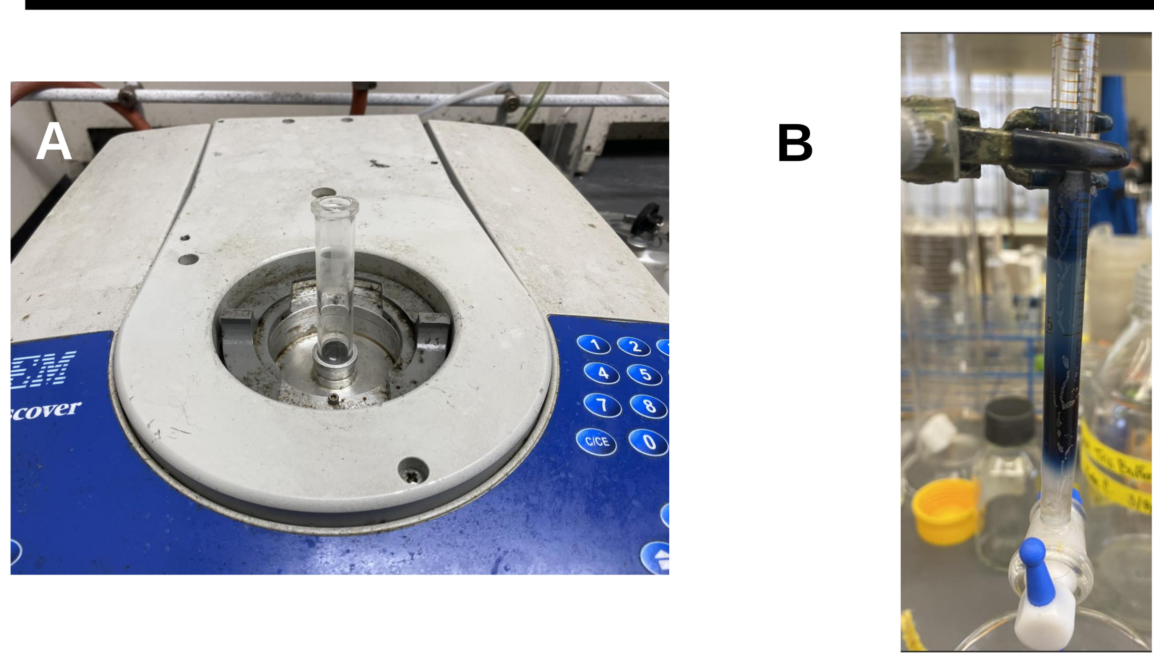


Figure 1. (A) CEM Microwave reactor with quartz synthesis vial (B) Chromatography column used to clean the Gd:WO_{3-x} particles

Gd: WO_{3-x} nanoparticle synthesis

- A microwave vial was filled with 30 mg of W_4Cl and 0.4 mL of Oleic Acid and varying percentage of $Gd(acac)_3$. A pulse sequence in the microwave was utilized to obtain the nanoparticles (Figure 1)
- Gd:WO_{3-x} nanoparticles are cleaned via chromatrography column and centrifugation with toluene and methanol

WO_{3-x} nanoparticle characterization

- UV-Vis Spectroscopy was obtained Perkin Elmer Lambda 950 UV/VIS/NIR Double Beam Absorption Spectrophotometer.
- Powder X-Ray diffraction completed on a Rigaku MiniFlex X-Ray Diffractometer
- Electron Paramagnetic Resonance (EPR)

Results

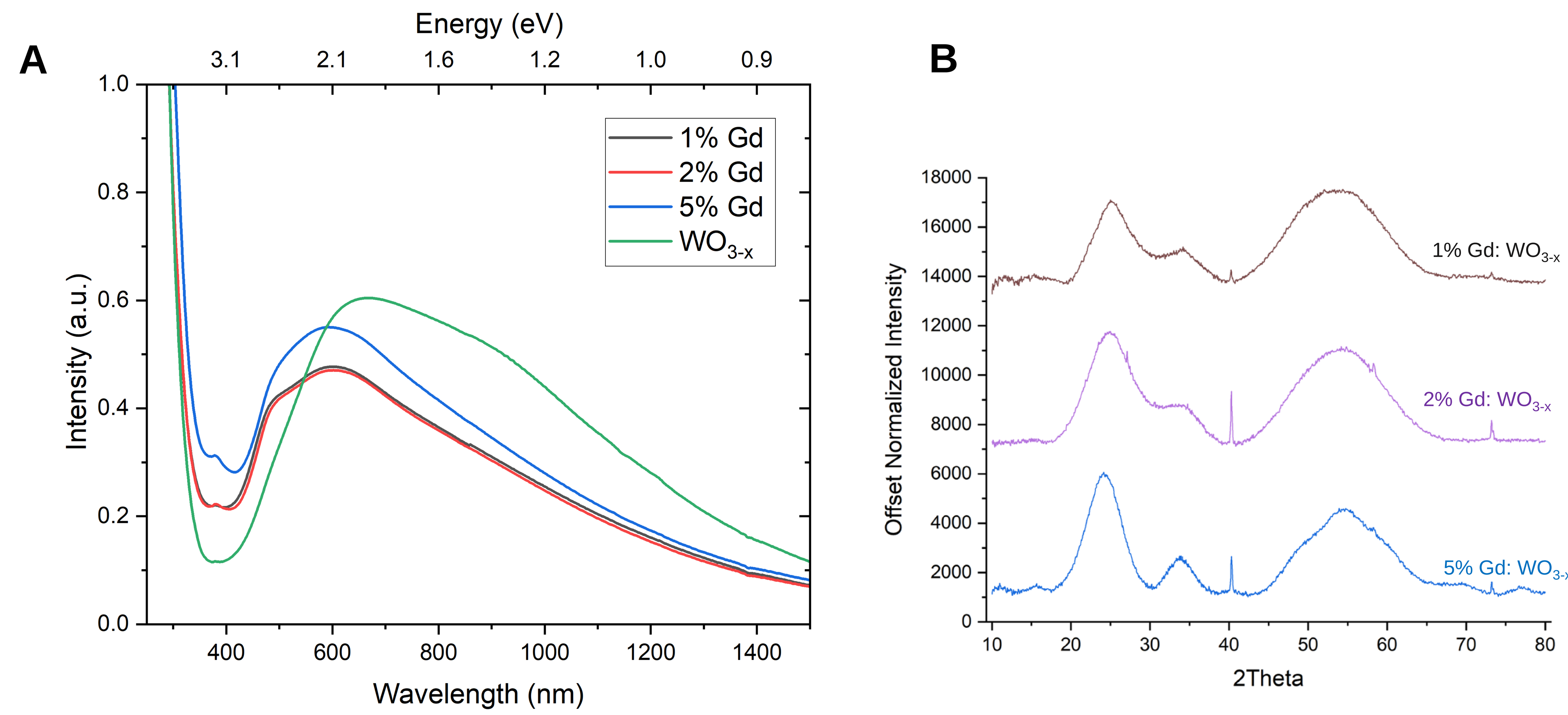


Figure 2. (A) UV-Vis spectra complete on a Perkin Elmer Lambda 950 UV/VIS/NIR Double Beam Absorption Spectrophotometer of Gd:WO_{3-x} samples. (B) Powder X-Ray (pXRD) diffraction of 1,2,5% Gd:WO_{3-x}

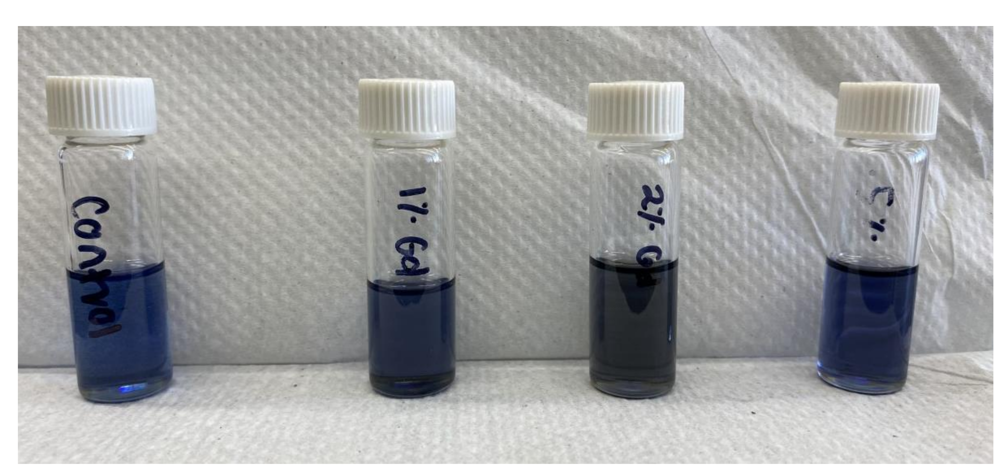


Figure 3. Image of the Gd:WO_{3-x} particles dissolved in toluene.

- Results show that the 5% Gd:WO_{3-x} results in the highest shifted plasmon energy.
- pXRD shows that we have successfully synthesized the WO_{3-x} nanocrystals
- EPR confirmed that Gd was successful doped into the WO_{3-x} system.

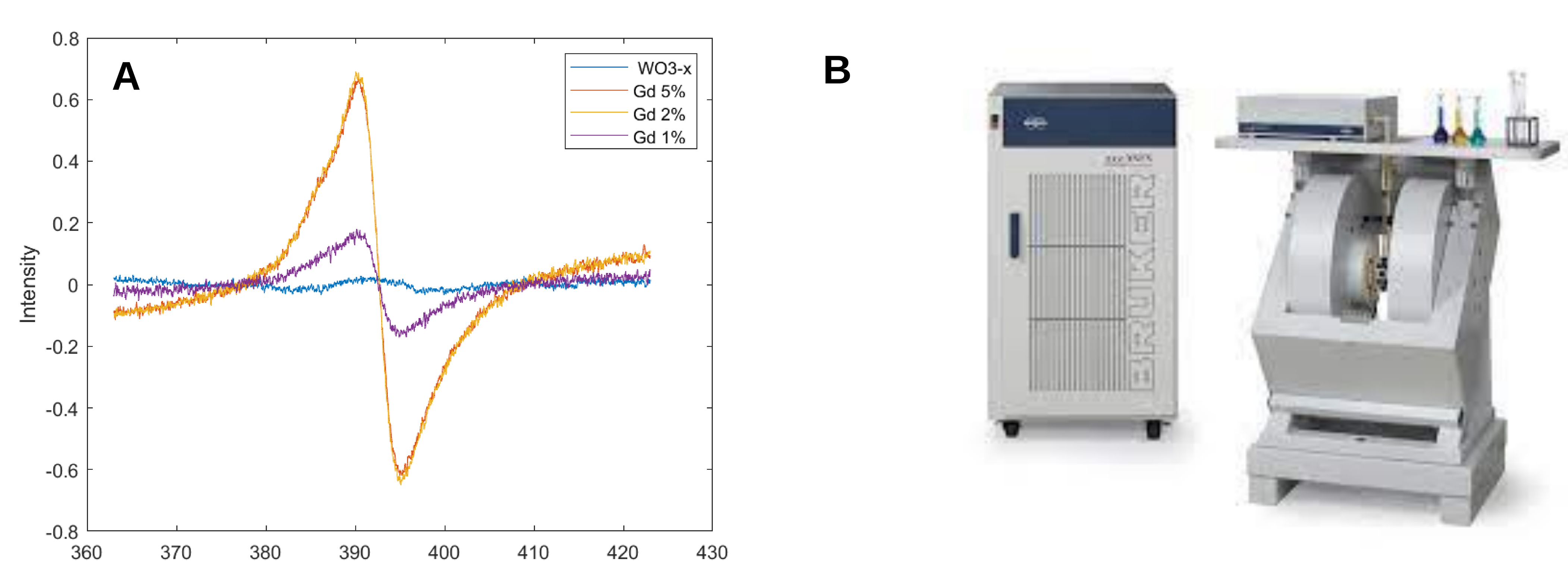


Figure 4. (A) EPR spectra of Gd:WO3-x samples on an X-Band ELEXSYS EPR Spectrometer (B) Image of BRUKER ELEXSYS EPR Spectrometer

Applications

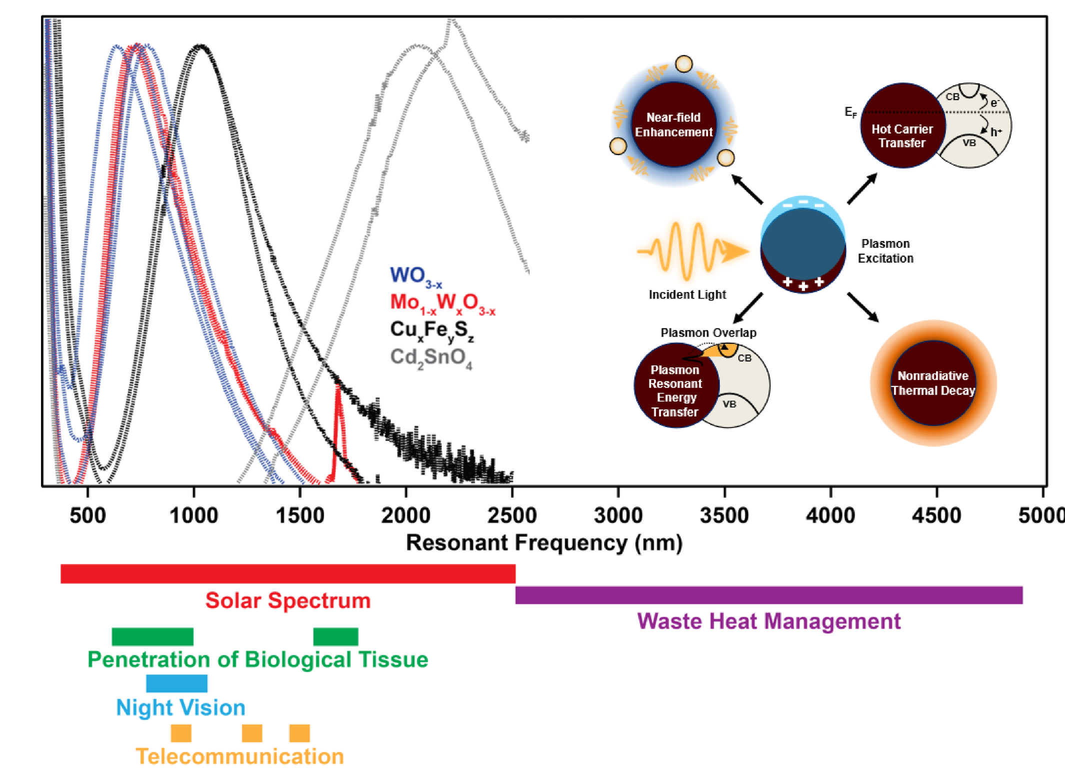


Figure 5. Applications of plasmonic semiconductor nanocrystals

As of now, our results are preliminary. Initial tests indicate that the gadolinium doped tungsten oxides have plasmons at lower wavelengths. This is incredibly useful in a variety of settings, as illustrated in the diagram above. We believe we have the ability to change the resonant frequency by changing the amount of dopant, which would allow us to use tungsten oxide nanoparticles in an even wider range of applications. This includes use in electrochromics, which change color with changing exposure to an electrical current. Electrochromic compounds can be used for temperature regulation through the development of smart windows, which can change color with changing electric current. This is an important field of research particularly in Florida, where temperature regulation is a necessary yet, at present, expensive investment for all buildings.

References

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Acknowledgments

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