Investigation of the Photophysics of WO_{3-x}

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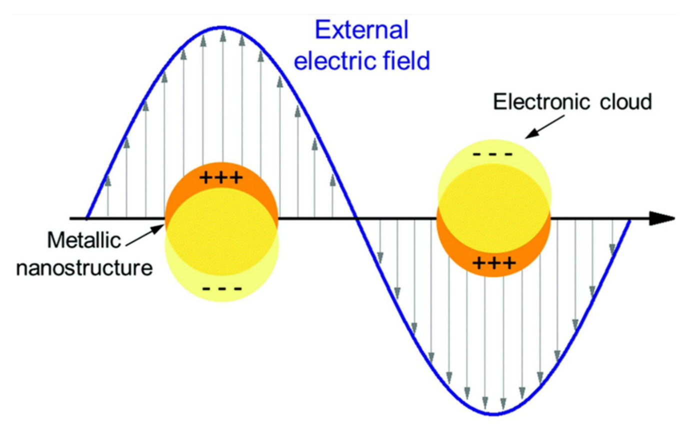
Introduction



- The interaction between incident light and nanoparticles leads to a confined high intensity non-propagating wave known as localized surface plasmon resonance (LSPR).
- The LSPR of WO_{3-x} can be tuned across the optical spectrum from visible to far-infrared by controlling the concentration of free carriers. This can be done by altering the dopant type, concentration, and distribution in the nanoparticle.

Nanoparticle Synthesis

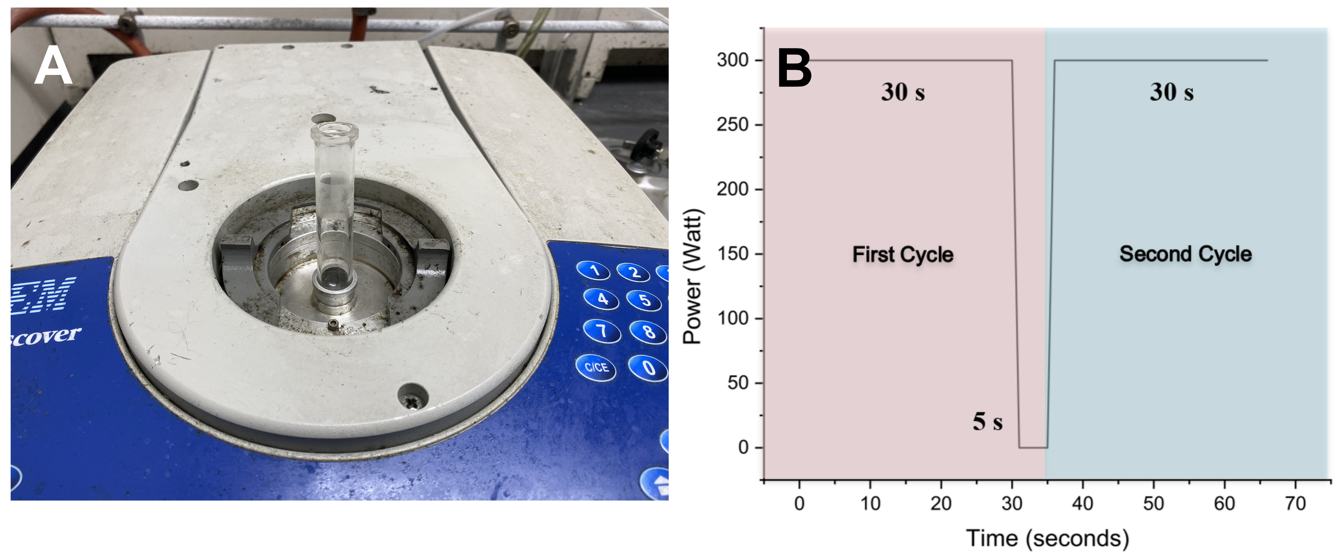


Figure 1. (A) CEM Microwave reactor with quartz synthesis vial (B) A single pulse sequence in the microwave consists of thirty seconds of continuous power at 300 W and five seconds of 0 W power and air cooling.

2 nm WO_{3-x} nanoparticle synthesis

- A microwave vial was filled with 30 mg of W_4Cl and 0.4 mL of Oleic Acid. A pulse sequence in the microwave was utilized to obtain the nanoparticles (Figure 1)
- WO_{3-x} nanoparticles are cleaned via 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

Results

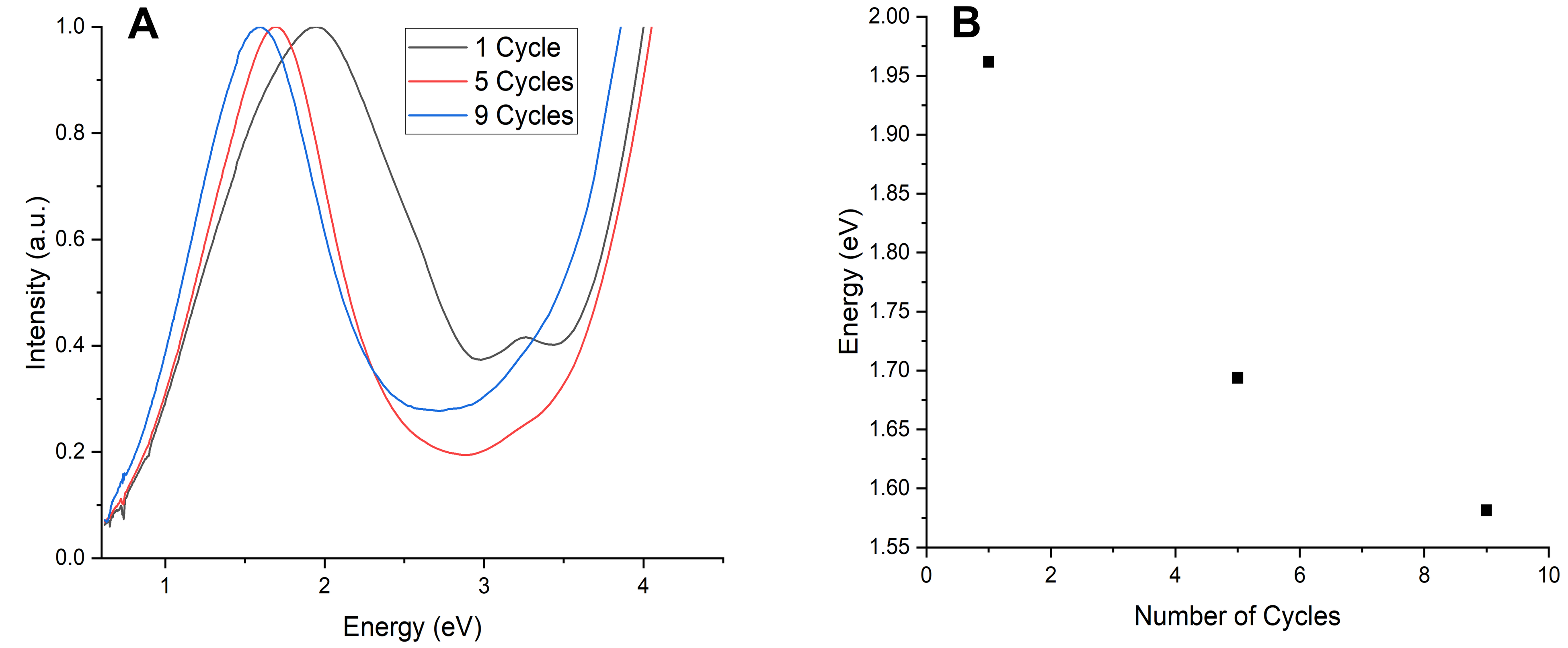


Figure 2. (A) UV-Vis spectra complete on a Perkin Elmer Lambda 950 UV/VIS/NIR Double Beam Absorption Spectrophotometer of the 1 Cycle, 5 Cycles, and 9 Cycle WO_{3-x} samples. (B) A graph depicting the plasmon frequency shift dependence on the number of microwave pulses.

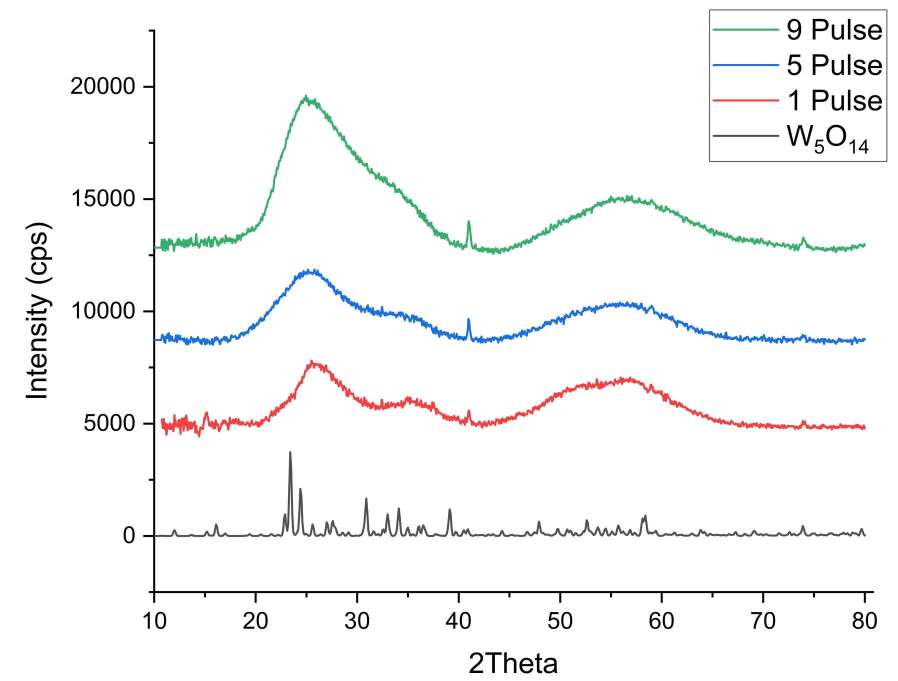


Figure 3, Powder X-Ray (pXRD) diffraction of 1,5, and 9 cycles samples of WO_{3-x}

- Results show that with increased microwave pulsing we improve the FWHM of the plasmon feature and decrease plasmon energy.
- pXRD shows that we have successfully synthesized the WO_{3-x} nanocrystals
- The Transmission Electron Microscopy (TEM) images concluded that the nanoparticle size is 2 nm

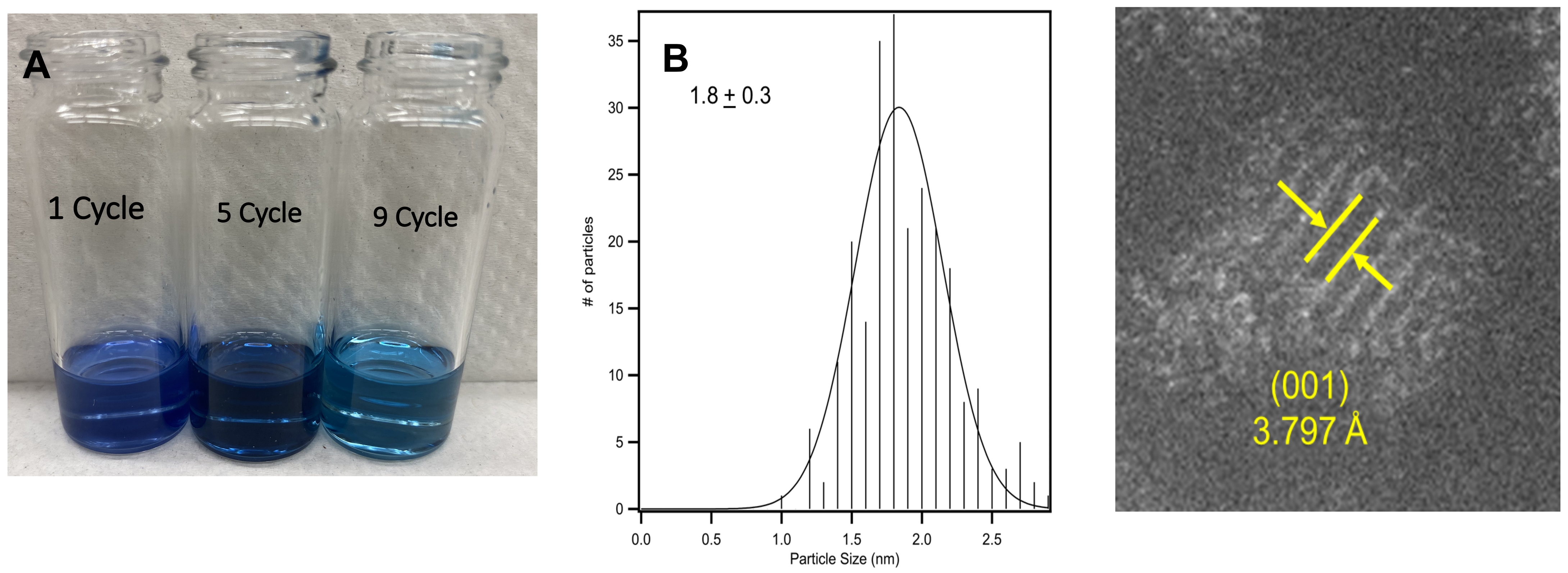


Figure 4. (A) Image of the 1 Cycle, 5 Cycles and 9 Cycles nanoparticles dissolved in toluene (B) HADF TEM of 9 pulse TEM with histogram with size distributions

Applications

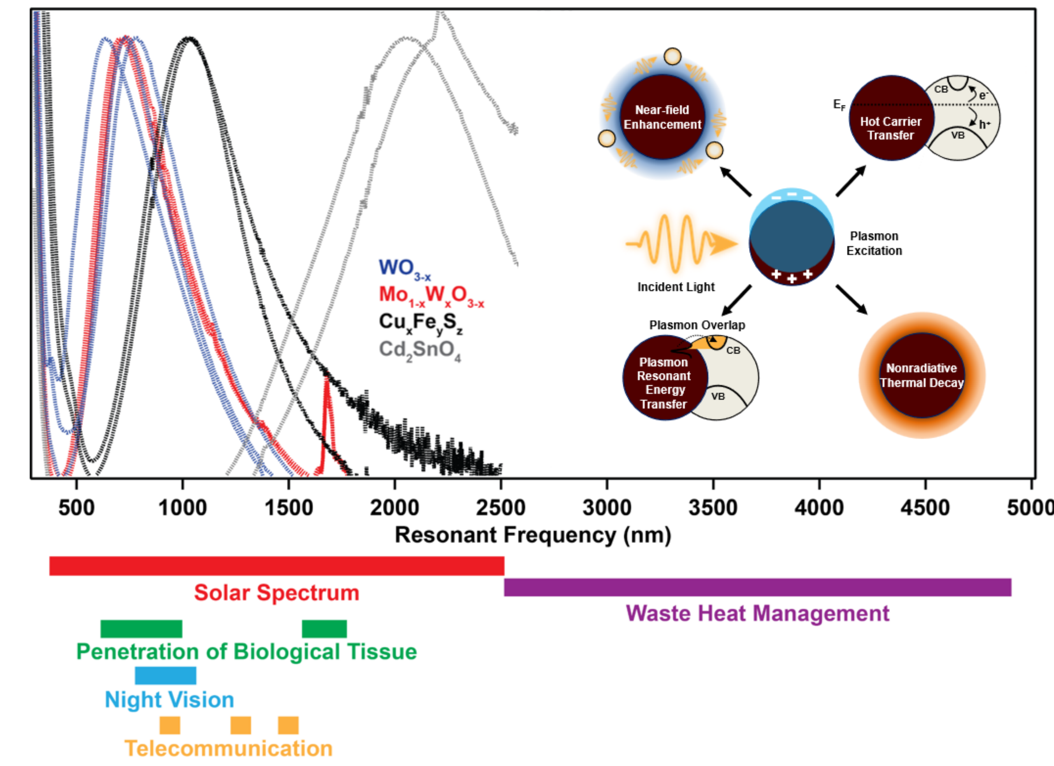


Figure 5. Applications of plasmonic semiconductor nanocrystals

- **Telecommunications applications**
- **Plasmon Enhanced Photocatalysis**
  - Two proposed mechanisms for photocatalysis are local electric field enhancement or charge transfer due to the generation of hot carriers
- **Electrochromics**
  - Used to prevent UV light and NIR light from entering the building
  - Works by applying voltage to the electrochromic material, which changes color overtime
- **Penetration of Biological Tissue**
  - LSPR-induced heat-based therapy and imaging

References

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