Electrochemical TNT Detection Utilizing VO_2 Particle Films

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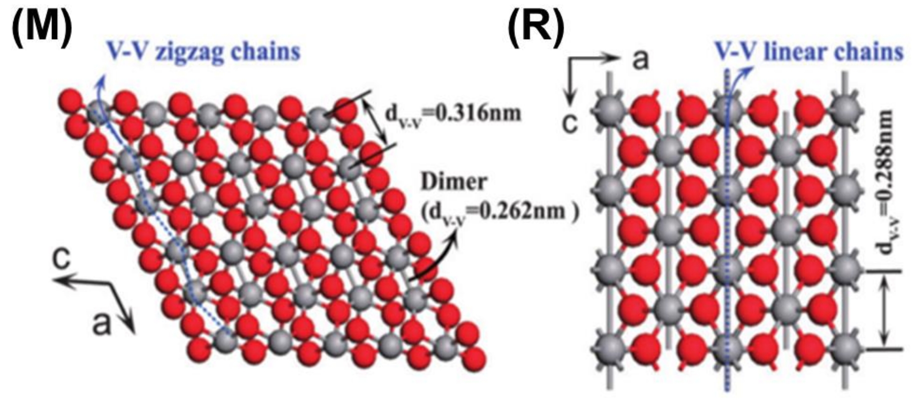
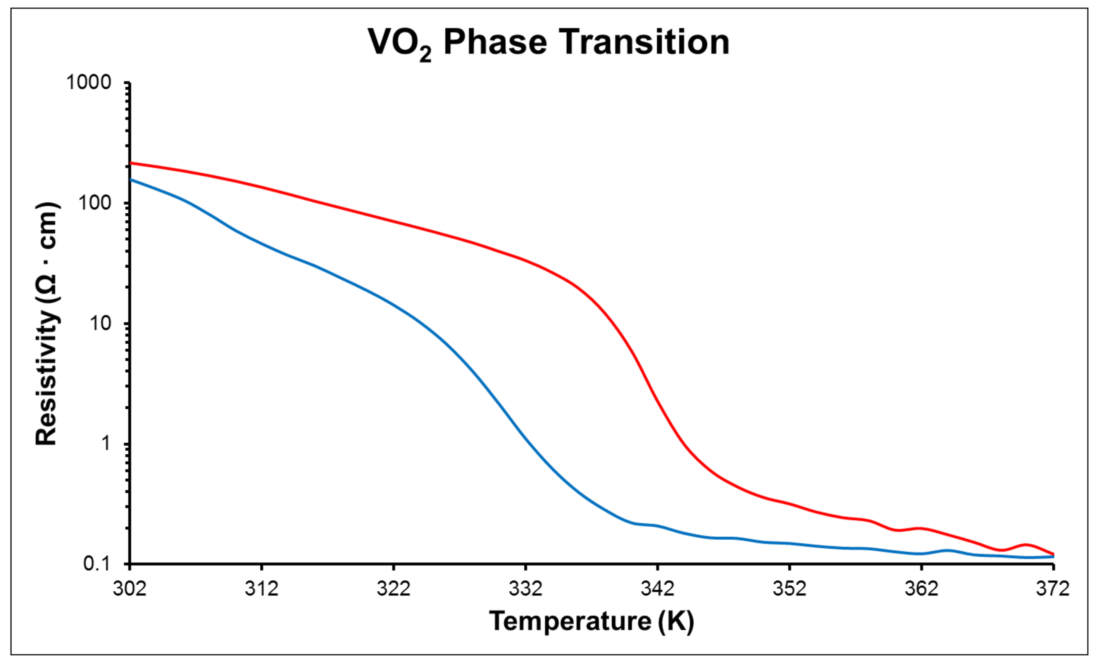
Introduction

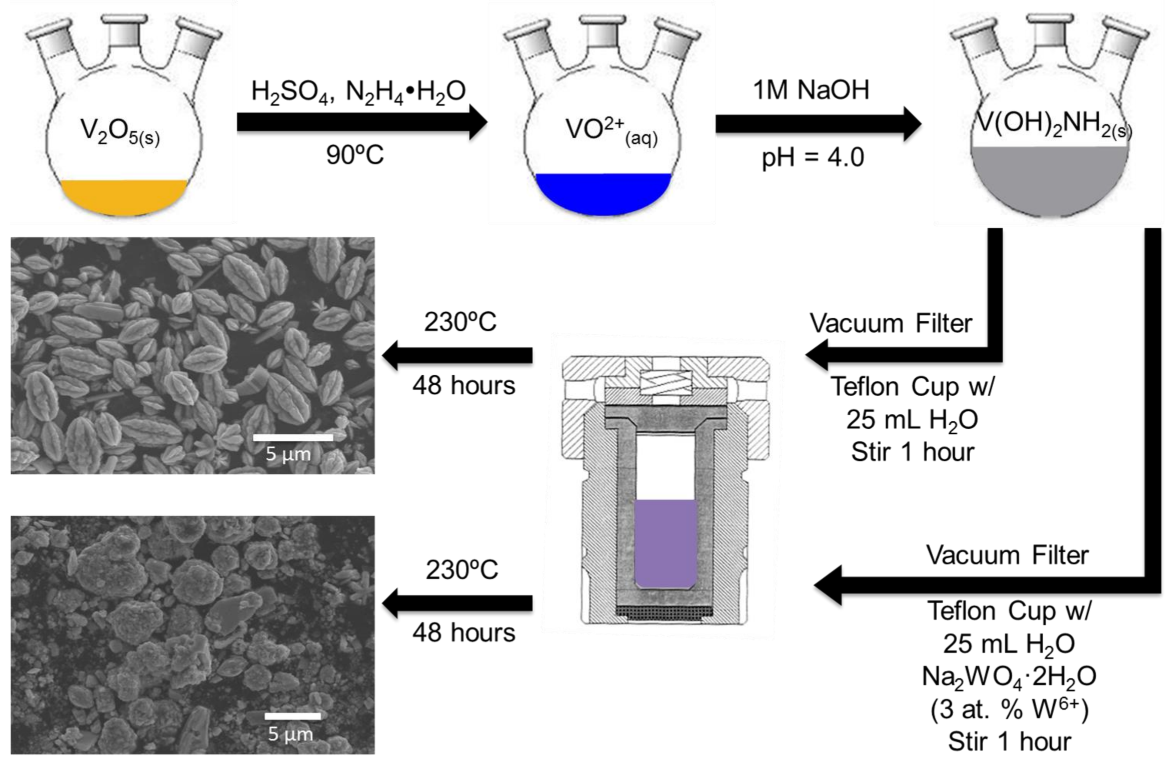
Due to its toxic nature, rapid and sensitive detection of 2,4,6-trinitrotoluene (TNT) is important for groundwater testing, especially near military bases or areas that have been exposed to large quantities of explosive materials. Previous research has shown that vanadium dioxide (VO_2) thin films have the ability to electrochemically detect TNT in solution. VO_2 is an interesting material that undergoes a phase transition at 68°C from a semiconducting monoclinic phase (M) to a metallic rutile phase (R).





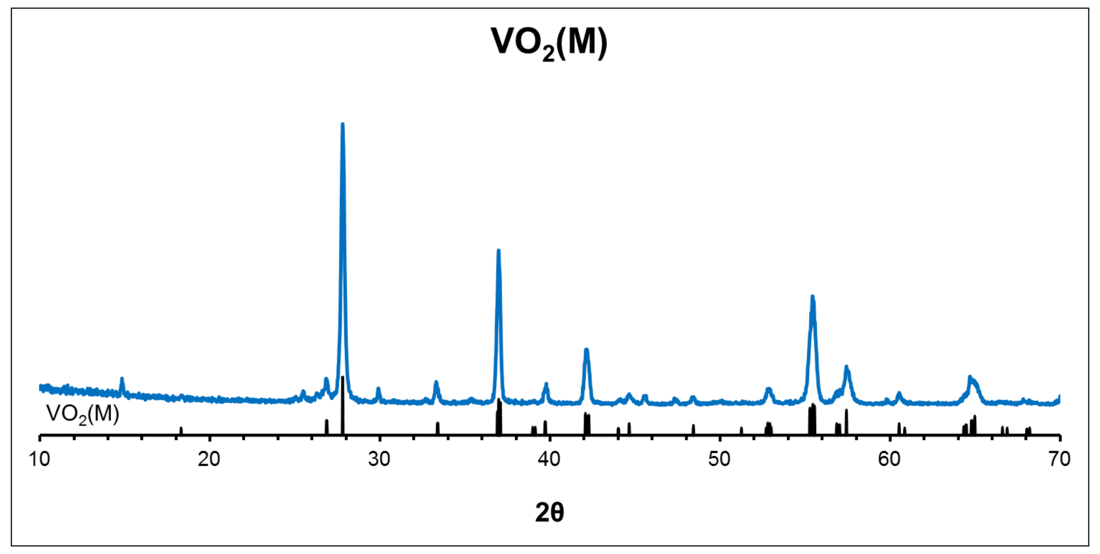
Methods

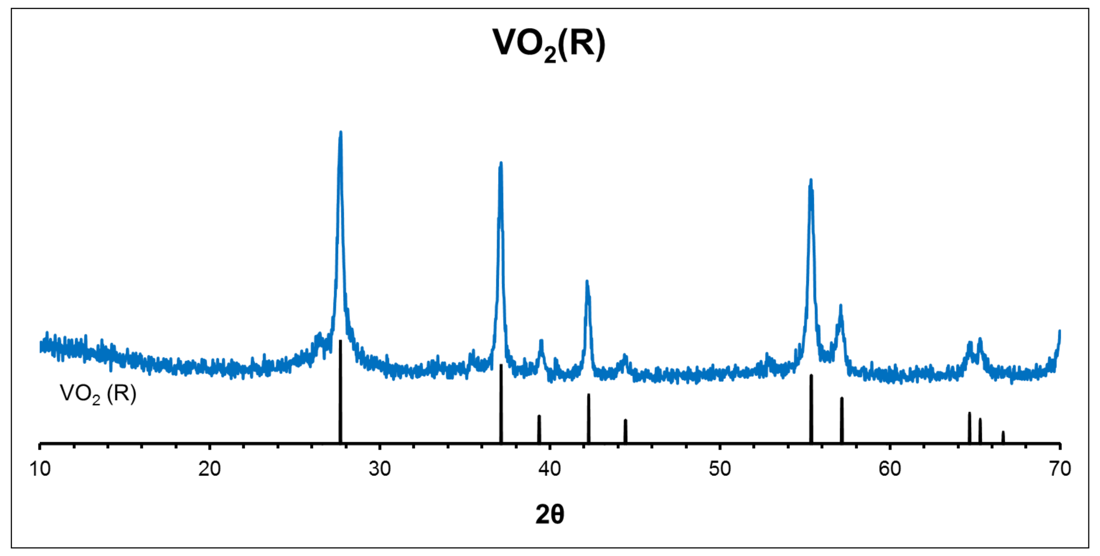
VO_2(M) particles were hydrothermally synthesized following the method depicted below. Additionally, doping the material with W^{6+} allowed access to the VO_2(R) phase at room temperature.



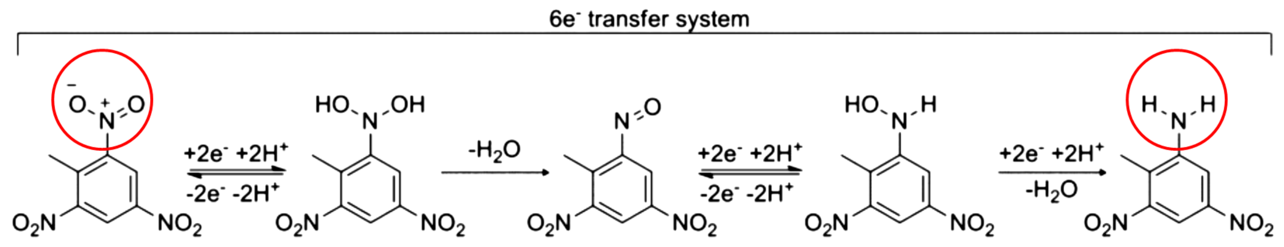
Results and Discussion

Powder x-ray diffraction patterns were used to confirm that the VO_2 particles were in either the M or R crystal phase.

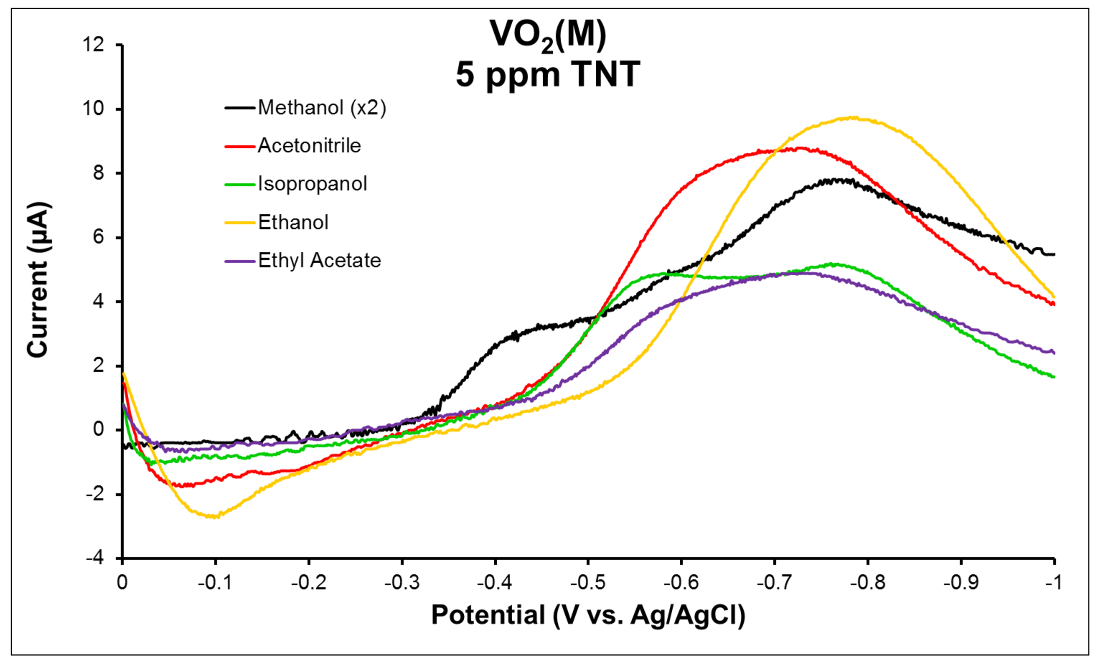


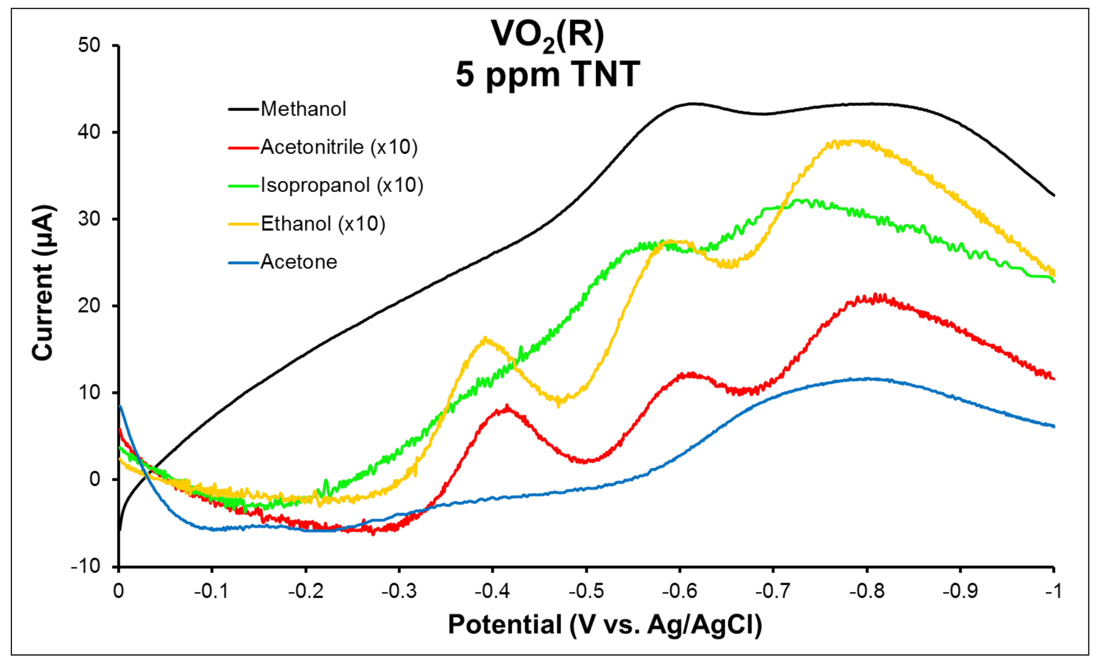


When detecting TNT via linear sweep voltammetry (LSV), three peaks should be present, one for each 6 e^- reduction of the three nitro groups into amines.

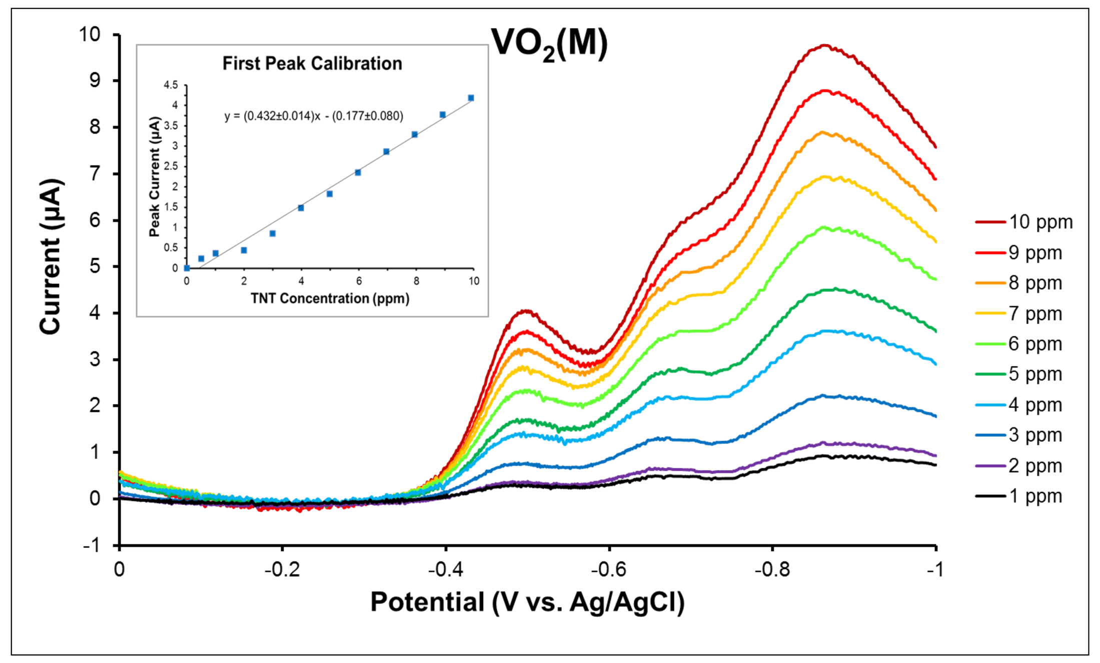


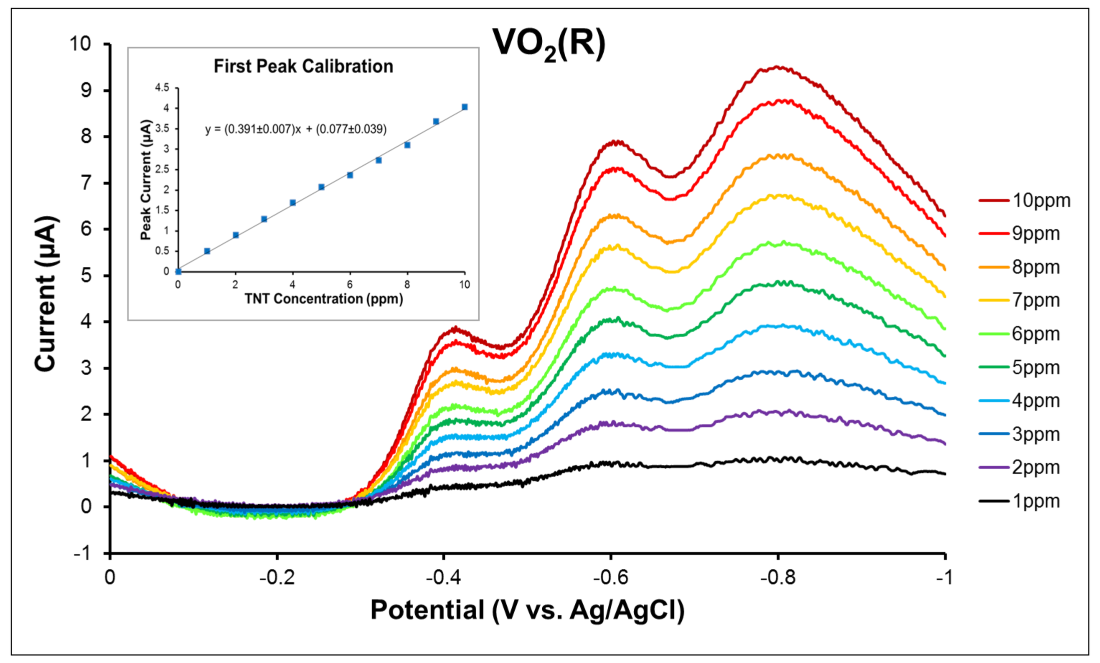
Various polar organic solvents were used to wash the particles and revealed that certain solvents either blocked or enhanced the particles' ability to detect TNT. Both plots are background subtracted.





Two solvents that enhanced the TNT detection were ethanol and acetonitrile for the VO_2(M) and VO_2(R) particle films, respectively. Again both plots are background subtracted.





Conclusion

VO_2(R) particles were successfully synthesized. When the VO_2(R) particles were washed in ethanol and acetonitrile, their particle films were able to detect TNT in solution very well. Initially, when the VO_2(M) particles were washed in ethanol they were able to detect TNT; however, reproducibility became an issue. Although more work must be done for conclusive results, the data thus far supports the hypothesis that being in the R phase enhances VO_2 particle films' ability to detect TNT when washed with either ethanol or acetonitrile.

References and Acknowledgements

REFERENCES:

[1] Wu, C. et al. *Chem. Soc. Rev.* **2013**, 42, 5157-5183.

[2] Son, J.-H. et al. *Chem. Mater.* **2010**, *22*, 3043–3050.

[3] Chua, C. K. et al. *J. Phys. Chem. C* **2012**, *116*, 4243-4251.

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