Electrochemical Reduction of 2,4,6-trinitrotoluene on Vanadium Dioxide

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Trinitrotoluene (TNT) and other explosives are important targets for detection in security and environmental applications. The last decade has seen increasing interest in using electrochemical methods to neutralize TNT, primarily through the reduction of the three nitro groups. Electrochemical methods are of particular interest due to the inherent selectivity, ease of use, low cost, short analysis time, and limits of detection. Although a variety of electrodes and preconditioning methods have been investigated in the context of TNT reduction, there remains a need for simple materials that can be applied in more practical settings.

Vanadium dioxide is one such material with strong potential applications as a sensing component. At relatively mild temperatures, it undergoes a phase transition to a rutile lattice structure under heating, which induces a change in its optical and electronic properties. This work exploits these properties in the design of a catalytic sensor that can provide analyte selectivity as well as a simple optical or electronic detection mechanism. Cyclic voltammetry was utilized to analyze the catalytic activity of VO_2-coated electrodes toward TNT reduction, and the subsequent effect on the phase transition properties of the VO_2 was then measured. This work shows that vanadium dioxide films and nanoparticles that have distinct phase transitions are active for electrochemical TNT reduction and detection.

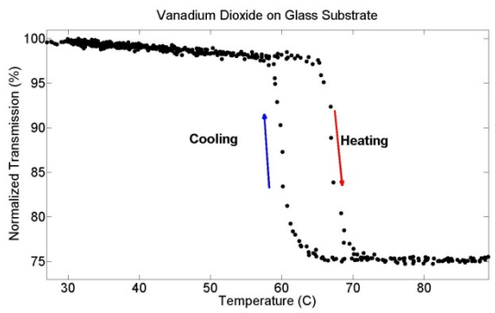

Figure 1. Phase transition in VO_2 induces a decrease in the optical transmission during heating, which returns to normal upon cooling and subsequent return to original phase.