Nanocluster Catalysts

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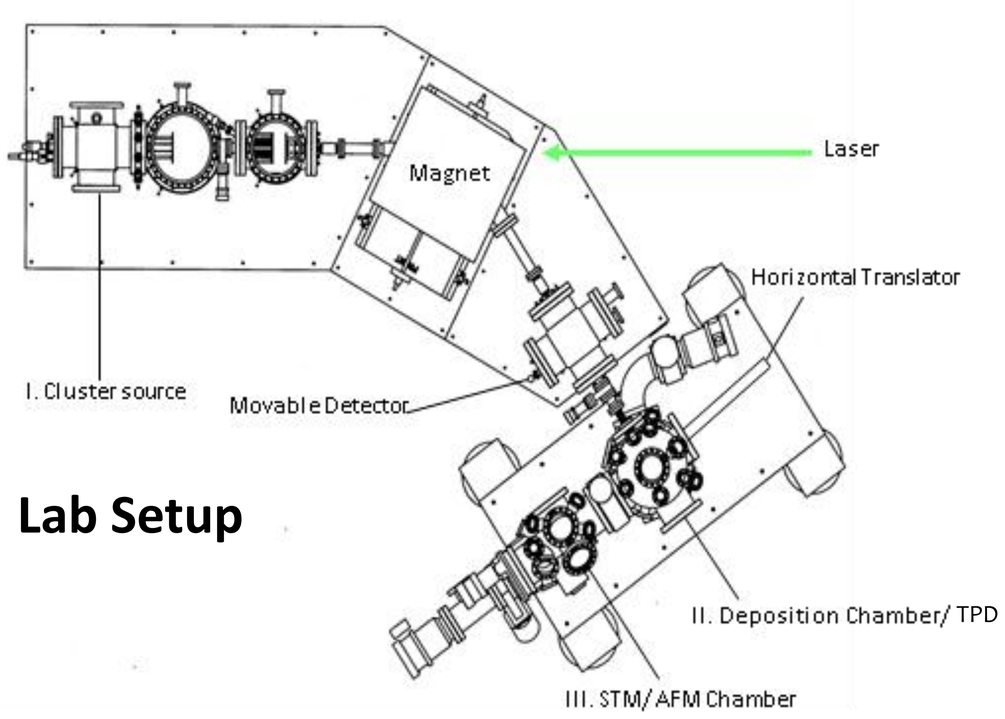
Introduction

Little is known about the catalytic behavior of vanadia nano-clusters as well as the structure of vanadia, V_xO_y, that actually participates in various industrial reactions. Our focus is on the role vanadia clusters play in the partial oxidation of methanol to formaldehyde because it is a relatively simple model system. From previous experiments we believe that the larger vanadium oxides such as VO_3, V_2O_5, and V_2O_6, are catalytically active. Our goal is to identify the catalytically active vanadia clusters and to experimentally determine the reaction mechanism of the partial oxidation of methanol to formaldehyde.

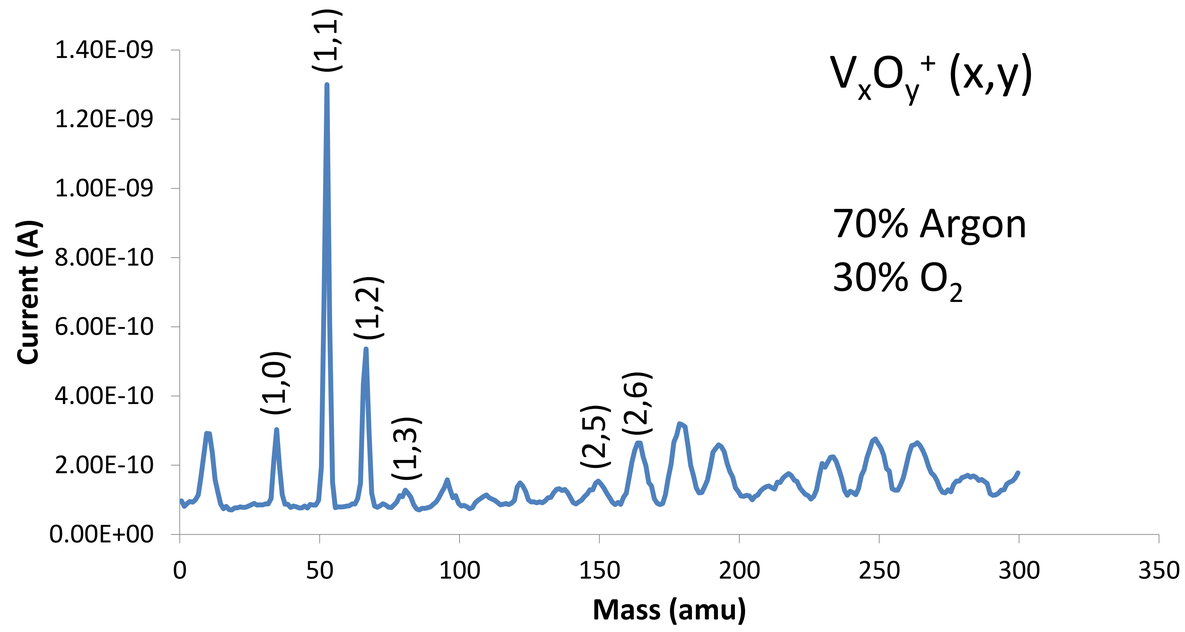
Methods

- Laser ablation is utilized with a pulsed YAG laser beam (532 nm, 500mJ/pulse max power) focused on a rotating, translating vanadium rod, producing gaseous vanadia ions
- Mass selection is performed by sending the ions through a curved flight tube affected by a specific magnetic field
- Soft landing the ions onto the TiO_2 surface (to prevent surface deformations) is performed by applying a voltage to the surface
- UHV-TPD (ultra-high vacuum-temperature programmed desorption) is used to determine the different species that desorb from the sample surface as a function of temperature

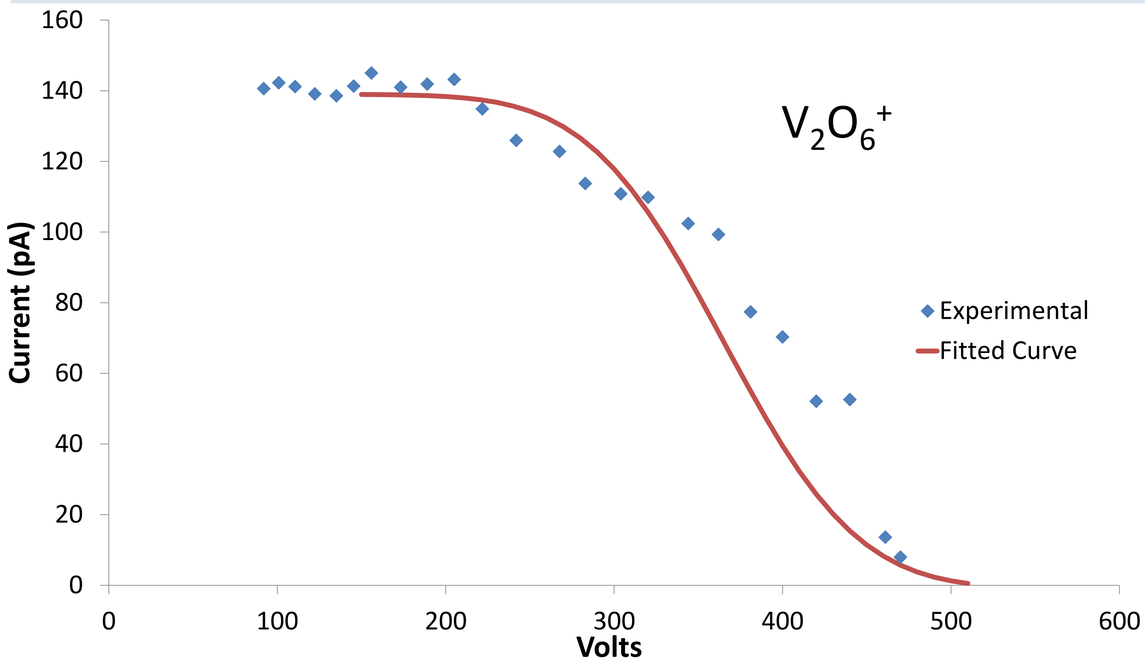


Lab Setup

Scanning for Vanadium Oxides



Kinetic Energy Distribution



The graph above shows the signal strength of $V_2O_6^+$ as a function of voltage. This distribution is used to determine the voltage that should be applied to the sample to soft land the ions.

Future Goals and Implications

Our immediate goal is to identify the catalytically active vanadia nano-clusters by TPD. The next step is to experimentally determine the reaction mechanism of our studied reaction. Once this information is known it will be possible to improve the efficiency of other reactions that use vanadia nano-clusters by synthesizing only the most catalytically active nano-clusters.

Literature Cited

Kemper, P.; Kolmakov, A.: Tong, X.; Lilach, Y.; Benz, L.; Manard, M.; Metiu, H.; Buratto, S.K.; Bowers, M.T. 2006. "Formation, deposition and examination of size selected metal clusters on semiconductor surfaces: An experimental setup." *International Journal of Mass Spectrometry 254:202-209.*

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