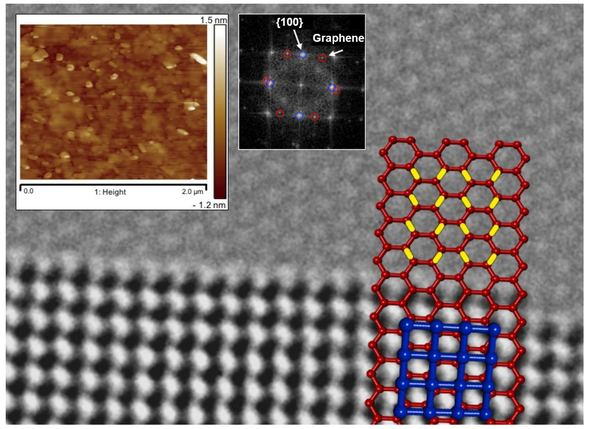
Alamgir Lab:

New generation of Materials for Energy Applications

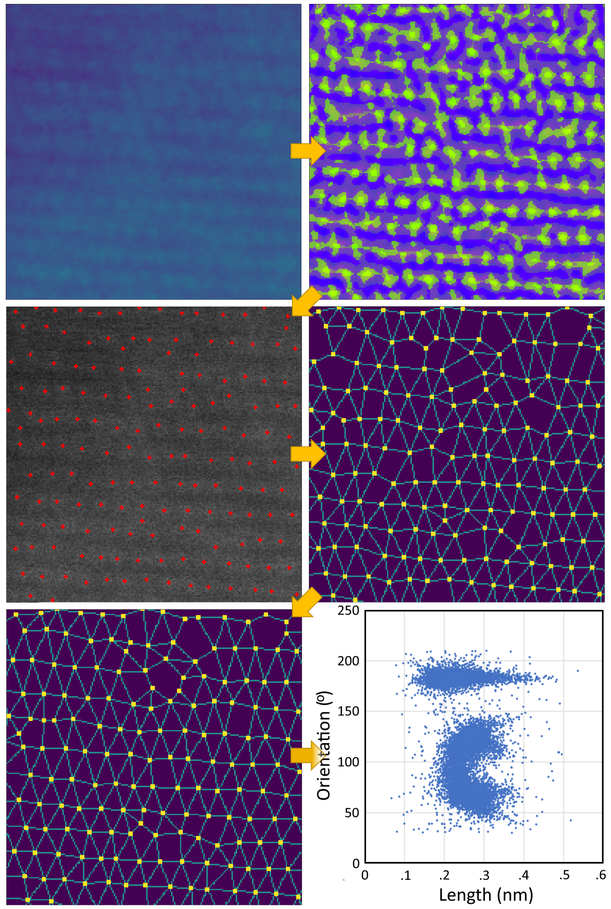
materials science and engineering

Georgia Tech

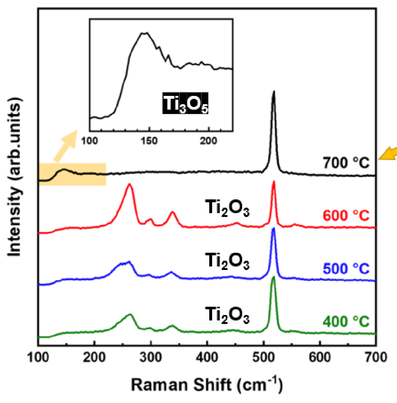
Metal-Graphene Catalysts & AI-based Analysis of STEM Images

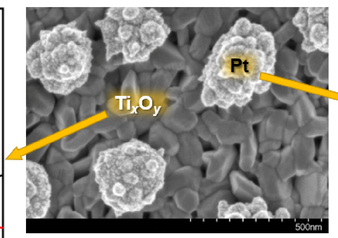


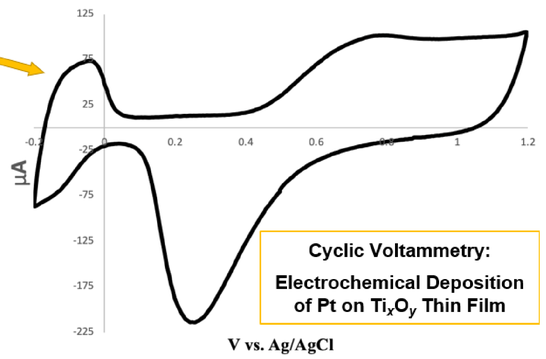
- The Alamgir group specializes in the synthesis and characterization of monolayer thick metal films on graphene. For catalysts of this type, one has unprecedented control of catalytic activity.
- Artificial intelligence based identification of atoms → connection in lattice → refinement → reconnection.
- Distribution of structural information, e.g. bond length and orientation, are obtained.
- When high volumes of images need to be processed, the determination of all input parameters can be automated to ensure that no human input is needed.



Catalyst Activity Tuned using Substrate Stoichiometry



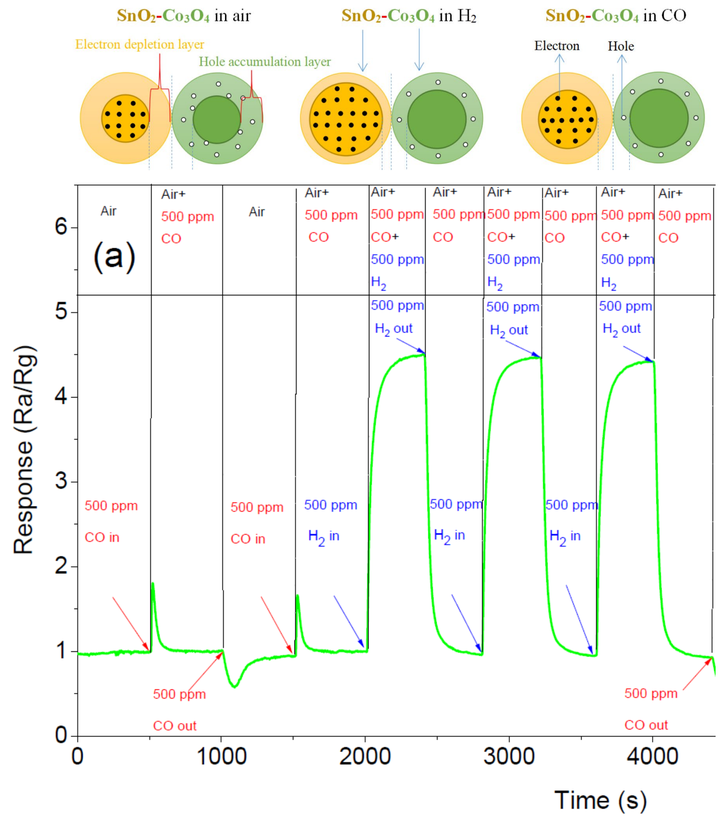




- Electronic properties and catalytic performance of Pt can be tuned by Ti_xO_y thin film support.
- Pulsed laser deposition (PLD) formed titania thin films with different substoichiometric phases at varying temperatures: Ti_2O_3 and Ti_3O_5.
- Stability and activity of Pt were dependent upon its particle morphology that can be controlled by reduction potential and electrolytes concentration in electrochemical deposition.
- Substoichiometric Ti_xO_y thin film demonstrated its role as an effective support for Pt stability; ~22% of Pt loss was observed after 30K cycles of accelerated stress test.

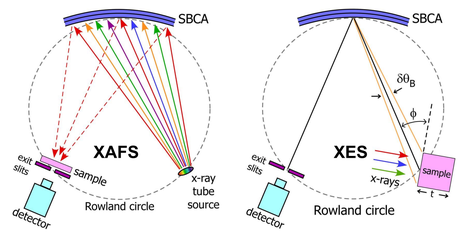
P-N Nanojunction based Gas Sensors with Ultra-High Selectivity

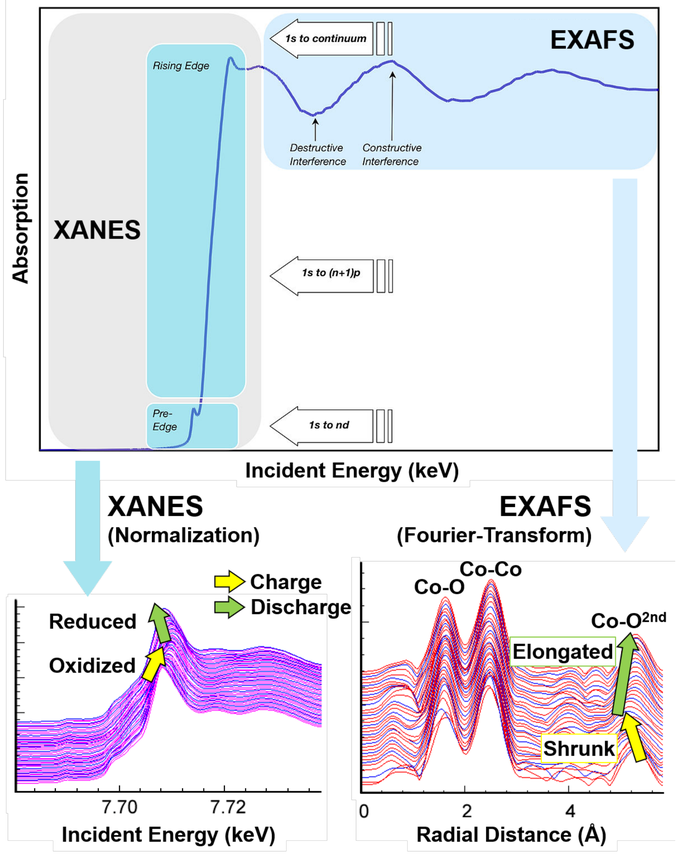
- p-n nanojunction of n-SnO_2/p-Co_3O_4 which selectively detected H_2 without the cross sensitivity of CO.
- Band theory: the enhanced electron conductivity (e^-) and the decreased hole conductivity (h^+) neutralized each other in the case of CO but not in the case of H_2.
- H_2 adsorbs and dissociates to H^+ ions, releasing electrons that increase the electronic conductivity of the n-type semiconductor metal oxides (SMO).



X-ray Absorption/Emission Spectroscopies for *Operando* Study

- X-ray absorption fine structure (XAFS) and x-ray emission spectroscopy (XES) are techniques that probe the element-specific atomic, chemical and electronic structure of materials.
- X-ray absorption near edge structure (XANES) identifying electronic structure: e.g. the oxidation state.
- Extended x-ray absorption fine structure (EXAFS) identifying atomic structure: bond distance and coordination number.
- XAFS and XES are particularly effective at investigating the real-time chemistry change in battery materials while they are simultaneously charged/discharged (i.e., *operando*).





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