



Design of Semiconducting Oxide Materials for Energy Conversion via Defect Engineering Discovery

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Location : Guyon Auditorium

Professor Edmund Seebauer

Department of Chemical and Biomolecular Engineering

University of Illinois at Urbana-Champaign, Urbana, IL

Abstract: The technologically useful properties of an oxide semiconductor often depend upon the defect types and concentrations. Defects such as vacancies and interstitials affect the performance of photoactive devices, the effectiveness of catalysts and photocatalysts, the sensitivity of solid-state electrolyte sensors, and the efficiency of solar energy conversion. We discovered several new methods for defect manipulation involving surfaces. Solid-state diffusion measurements in TiO_2 and ZnO , together with detailed mathematical modeling, have identified new interactions between surface and bulk point defects having comparable chemical richness to gas-surface reactions, and governed by electrostatic and surface bond insertion/generation mechanisms. We demonstrate several instances in which defect engineering has improved photocatalysts as well as catalysis by metals. In particular, defect-engineered control of both carrier concentration and surface potential in polycrystalline anatase TiO_2 yield improvements in photocatalysis rates that accord closely with a simple mathematical model for photocurrent.

Edmund G. (Ed) Seebauer is James W. Westwater Professor of Chemical & Biomolecular Engineering at the University of Illinois at Urbana-Champaign. His research focuses on the engineering of atomic-scale defects in semiconducting oxides to make nanoscale devices, catalysts, and photocatalysts of interest in microelectronics, energy and environment applications.

He has received a Sloan Research Fellowship in Chemistry and an Inventor Recognition Award from Semiconductor Research Corporation, and is currently a Fellow of the American Association for the Advancement of Science, the American Institute of Chemical Engineers, the American Physical Society and the American Vacuum Society. He has roughly 190 journal and conference publications, 4 patents, and 2 books on charged defects in semiconductors as well as engineering ethics. He served 6 years until 2011 as Head of his Department, and subsequently as a special-assignment Associate Provost until 2014, focusing on international academic programs.