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Ming Hsieh Department of Electrical and Computer Engineering

Ming Hsieh Institute **Seminar Series**

Semiconductors and Microelectronics Technology

Autonomous experiments for thin films and solid materials

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Date: Friday, May 16th, 2025

Time: 1:30 – 2:30pm PT | Location: EEB 248

https://usc.zoom.us/j/91790139773?pwd=QWpnKzdQVldnMlZSOHVaYUVaSXNIZz09

Abstract: Autonomous experiments, integrating machine learning and robotics, are revolutionizing materials science research. This approach accelerates the discovery and optimization of novel materials by automating the experimental process and enabling the exploration of vast parameter spaces.

We present an autonomous experimental system for thin-film materials research. This system automates all stages of the experimental process, including sample handling, thin-film deposition, optimization of growth conditions, and comprehensive data acquisition (X-ray diffraction, scanning electron microscope, Raman spectroscopy, etc.). By combining robotic control with Bayesian optimization, our system autonomously explores the parameter space and identifies optimal conditions.

We demonstrate this approach by synthesizing and maximizing the electrical conductivity of Nb-doped TiO2 thin films. Furthermore, this autonomous system has enabled the discovery of new ionic conductors. This work highlights the potential of autonomous experimentation for accelerating materials science research, particularly for solid-state materials. We are currently developing an autonomous experimental system for synthesizing bulk materials.

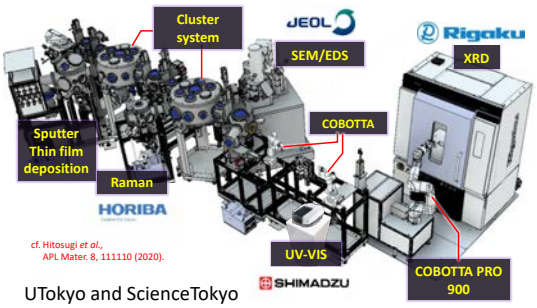
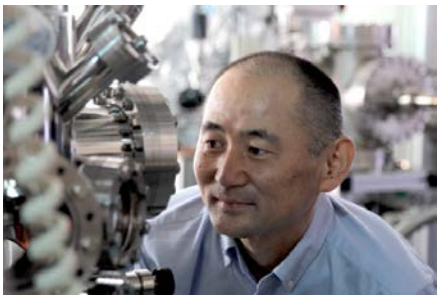


Figure: Autonomous experimental system for thin-film material exploration.

[1] N. Ishizuki, R. Shimizu, and T. Hitosugi, STAM Methods 3, 2197519 (2023).
[2] Autonomous materials synthesis by machine learning and robotics. R. Shimizu, T. Hitosugi *et al.*, APL Mater. 8111110 (2020).
[3] Autonomous exploration of an unexpected electrode material for lithium batteries. S. Kobayashi, R. Shimizu, Y. Ando, T. Hitosugi, ACS Materials Lett. 5, 2711–2717 (2023).



Biography: Taro Hitosugi is a Professor of Chemistry at The University of Tokyo. He received his Ph.D. from The University of Tokyo in 1999 and began his career at Sony Corporation. In 2003, he transitioned to academia, holding positions as an Assistant Professor at The University of Tokyo and Associate Professor at Tohoku University before becoming a full professor at the Tokyo Institute of Technology in 2015. He returned to The University of Tokyo in 2022.

An expert in solid-state chemistry, thin film, and surface and interface science, Professor Hitosugi's research focuses on materials for electronics and energy applications. His work includes the development of autonomous material synthesis using machine learning and robotics to accelerate materials science research. He has authored more than 200 peer-reviewed publications in leading academic journals. He serves on the editorial advisory board of *APL Materials* and as an associate editor for *Science and Technology of Advanced Materials (STAM)*. Professor Hitosugi contributes his expertise to the Cabinet Office's "Materials Strategy" and the Science Council of Japan.

Hosted by Prof. J. Joshua Yang, Prof. Chongwu Zhou, Prof. Stephen Cronin, and Prof. Wei Wu.
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