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**Safe Learning-based Predictive Control of Low-temperature Plasmas
using Deep Neural Networks and Gaussian Processes**

Ali Mesbah
University of California Berkeley

Learning-based control is a form of adaptive control, whereby controller and/or process model parameters are modified based on system measurements. Learning-based control can create unprecedented opportunities for process control of low-temperature plasmas (LTPs), which are increasingly used for treatment of heat and pressure sensitive (bio)materials in surface etching/functionalization, environmental, and biomedical applications. Some of the main challenges in process control of LTP applications arise from their inherent complexity and variability. Firstly, the dynamics of LTPs are highly nonlinear and spatio-temporally distributed, which are both expensive and also difficult to model due to their mechanistic complexity. Secondly, the LTP effects on complex surfaces are generally poorly understood. And thirdly, LTPs exhibit run-to-run variations and time-varying dynamics, whereby the same experiment may be carried out under similar conditions, but yield different results. In this talk, we will demonstrate the usefulness of learning-based predictive control approaches for LTP treatment of complex surfaces. We will discuss how machine learning approaches such as Gaussian process regression and deep neural networks can be leveraged to learn the complex plasma and surface dynamics in real-time, toward safe and high-performance LTP treatment of complex surfaces.

Short Bio

Ali Mesbah is Associate Professor of Chemical and Biomolecular Engineering at the University of California at Berkeley. Before joining UC Berkeley, Dr. Mesbah was a senior postdoctoral associate at MIT. He holds a Ph.D. degree in Systems and Control from Delft University of Technology. Dr. Mesbah is a senior member of the IEEE and AIChE. He serves on the IEEE Control Systems Society Conference Editorial Board and IEEE Control Systems Society Technology Conference Editorial Board, and is a subject editor of Optimal Control Applications and Methods and IEEE Transactions on Radiation and Plasma Medical Sciences. Dr. Mesbah is recipient of the Best Application Paper Award of the IFAC World Congress in 2020, the AIChE's 35 Under 35 Award in 2017, the IEEE Control Systems Outstanding Paper Award in 2017, and the AIChE CAST W. David Smith, Jr. Publication Award in 2015. His research interests lie at the intersection of optimal control, machine learning, and applied mathematics, with applications to learning-based analysis, diagnosis, and predictive control of materials processing and manufacturing systems.