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"Physics-informed AI - an enabling paradigm in semiconductor manufacturing, with a case study in photolithography overlay control"

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Bio: **Dragan Djurdjanovic** obtained his B.S. in Mechanical Eng. and B.S. in Applied Mathematics in 1997 from the Univ. of Nis, Serbia, his M.S. in Mechanical Eng. from the Nanyang Technological Univ., Singapore in 1999, and his M.S. in Electrical Eng. and Ph.D. in Mechanical Eng. in 2002 from the Univ. of Michigan, Ann Arbor. Dr. Djurdjanovic explores methodologies for transforming data into useful information and further into operational decisions, with applications in advanced manufacturing, automotive engineering and biomedical systems. He served as the Director of the NSF Industry-University Cooperative Research Center on Intelligent Maintenance Systems (IMS Center) at the University of Texas at Austin from 2013 until 2020, and served as the Associate Director of the NSF Engineering Research Center on Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies (NASCENT Center) from 2018 until 2023. Dr. Djurdjanovic is a Fellow of the International Society for Engineering Asset Management (ISEAM), Associate Member of the International Academy for Production Research (CIRP) and is the recipient of several prizes and recognitions, including the 2018 August-Wilhelm Scheer Visiting Professorship from Technical University of Munich and 2006 Outstanding Young Manufacturing Engineer Award from the Society of Manufacturing Engineers (SME).

Abstract: The talk will offer an overview of methodologies which enable mining of large amounts of data in semiconductor manufacturing based on the methods which fuse first-principle physics with concepts of Machine Learning (ML) and Artificial Intelligence (AI). Details will be offered on the benefits and powers of this paradigm in photolithography process control. Specifically, the focus will be on the recently-developed robust optimization-based method for distribution-agnostic and stochastic-structure agnostic control of maximal photolithography overlay errors. This approach addresses the reality that with ever-shrinking feature sizes, Central Limit Theorem fails to result in tractable noise distributions in photolithography models, necessitating a distribution and stochastic structure agnostic control algorithm. Furthermore, circuit functionality depends on the worst-case misalignments between pattern layers, which necessitates control of maximal overlay errors rather than the traditional MIMO control metric of their sum-of-squares. Exploiting the tractability of this control approach, a Genetic Algorithm is proposed to optimize the number and allocation of overlay measurement markers in a way that the performance of the resulting overlay control algorithm is maximized given a limited number of available measurement markers. Simulations based on the data and models from a lithography process used in a major 300mm wafer fab indicate that the novel control approach can outperform the traditional Run-to-Run overlay errors control, while using measurements from as few as 50% of available markers, which could lead to tremendous cycle-time savings. The talk will end with a discussion on the future needs of and opportunities for research in the realm of data analytics in semiconductor manufacturing.