The MADEin4 Project: Driving Smart Manufacturing Excellence in the Semiconductor Industry

Recent Innovations in Integrated Metrology

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Abstract
Integrated metrology (IM) is the workhorse metrology in manufacturing and a key enabler to process control. Integrated tools typically reside on the same platform as the process tool and allow easy, dedicated feed-forward and feedback for much tighter process control. In-die-based W2W (Wafer to Wafer) control is essential for yield performance in advanced technology nodes. Increased complexity of design rules and more process steps add new requirements for integrated metrology. Strong demand to measure directly on the device for better process control, new requirements for measurement of thin residues directly on structure, more parameters to be extracted from each measurement, and tightening the process window require continuous innovations in integrated metrology solutions. All these requirements need to meet sampling and cost of ownership targets for High Volume Manufacturing (HVM) control. Recent developments in artificial intelligence (AI) and Machine Learning (ML) can be implemented with IM solutions to comply with such requirements.
ML and AI have exhibited an increased demand in semiconductor fabs, and their presence is rapidly growing. There are multiple reasons to adopt ML solutions in HVM fabs, such as fast time to solution, reduction of measurement error, and high productivity. ML solutions leveraging high accuracy reference metrology data or/and electrical test data have also been proven to optimize measurement sensitivity to actual process excursions that correlate to the electrical data.
As a market leader, Nova continues to drive both AI and HW innovations into the IM world. Such innovations include new process control capabilities enabled by AI and advanced Machine Learning algorithms as well as Multi-Channel Integrated metrology. In this work, we will discuss and demonstrate these and other new directions to enhance IM.

Biography
Mr. Ovadia Ilgayev is a semiconductor metrology professional with over 9 years of experience in the field. Mr. Ilgayev has been holding various positions in Nova LTD, such as Application Scientist and Application Team Leader, where he was responsible for application development for R&D activities from initial feasibility experiments and theoretical work to a beta tool at various customer sites. In his current role in Product Management department, he is working on Integrated Metrology solutions, addressing requirements for metrology challenges, adjusting products roadmap, and proliferating solutions in customer sites.
Mr. Ilgayev holds a B.Sc degree in Physics and Mathematics, and an M.Sc degree in Biomedical Engineering from Technion, Israel Institute of Technology.

IMOCO4.E: Intelligent Motion Control under Industry4.E

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Abstract
The IMOCO4.E target is to provide vertically distributed edge-to-cloud intelligence for machines, robots and other human-in-the-loop cyber-physical systems having actively controlled moving elements. They face ever-growing requirements on long-term energy efficiency, size, motion speed, precision, adaptability, self-diagnostic, secure connectivity or new human-cognitive features.

IMOCO4.E strives to perceive and understand complex machines and robots. The two main pillars of this project are digital twins and AI principles (machine learning/deep learning). These pillars build on the IMECH reference framework and methodology, by adding new tools to layer 3 that delivers an intelligible view on the system, from the initial design throughout its entire life cycle. For effective employment, completely new demands are created on the Edge layers (Layer 1) of the motion control systems (including variable speed drives and smart sensors) which cannot be routinely handled via available commercial products.

On the ground of this, the subsequent mission of this project is to bring adequate edge intelligence into the Instrumentation and Control Layers, to analyse and process machine data at the appropriate levels of the feedback control loops and to synchronise the digital twins with either the simulated or the real-time physical world. At all levels, AI techniques are employable.

Summing up, IMOCO4.E strives to deliver a reference platform consisting of AI and digital twin toolchains and a set of mating building blocks for resilient manufacturing applications. The optimal energy-efficient performance and easy (re)configurability, traceability and cyber-security are crucial.

The IMOCO4.E reference platform benefits will be directly verified in applications for semiconductor, packaging, industrial robotics and healthcare. Additionally, the project demonstrates the results in other generic “motion-control-centred” domains. The project outputs will affect the entire value chain of the production automation and application markets. Through the further evolved I-MECH methodology, it creates a sustainable proposition, such as “digital twins as a service” or “machine design as a service”, for the ongoing smartification of industries and shortening of innovation cycles.

Biography
Sajid Mohamed is a principal software engineer at Nexperia ITEC in the R&D innovation team.

Gijs van der Veen is a motion control architect at Nexperia ITEC, working on next-generation semiconductor assembly equipment.

Nexperia ITEC is a semiconductor equipment and automation technologies provider with over 30 years of experience that enable the production of over 90 billion devices annually. Within IMOCO4.E, ITEC is a work package leader and provides a pilot application as a case study.