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Artificial Intelligence and Robotics in Semiconductor Industry - The MADEin4 Initiative

Go Faster for Process Deviation: Fast Errors Detections on Large Surfaces Using Ellipsometry

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Abstract

The ongoing MadeIn4 European project purpose consists in developing new Industry 4.0 metrology approaches driven by predictive in line control requirements and this at the frontier between academic studies and industrial world. LTM academic lab has a strong expertise in innovative metrology and leads the use of the advances characterization modules of the IMPACT platform, a unique metrology tool set based on versatile and powerful hybrid Lab techniques implemented on an Inline 300mm platform. LTM contributions in MadeIn4 are in line with Booster 1: Increase Knowledge and Robustness and Booster 2: Go Faster. This close collaboration with STMicrolelectronics addresses three tasks. First one concerns the Hybridation between XPS (IMPACT modules) and several optical techniques (Ellipsometry and Raman IMPACT module) for ultra-thin film metrology. Second tasks address the Robustness improvement of metrology standards accuracy through CD-SAXS measurements in partnership with LETI with an Artificial Intelligence based approach. Finally, last task targets the development of an innovative strategy for fast critical errors detections in large surfaces 3D patterns by Ellipsometry / Polarimetry IMPACT modules using a very fast model less approach. This last task will be detailed in this communication.

Metrology tools are known to exhibit high sensitivity in order to measure small changes in properties or morphologies of materials used in industrial processes. Among these tools; Ellipsometry and Scatterometry are optical equipments that are widely used for refractive index measurements and morphological analysis of stacked patterned layers that are deposited during the fabrication flows in microelectronic. Accuracy and reproducibility of the measurements are mandatory for the metrology control of a process, accuracy fulfilled thanks to the elaboration of an accurate model. The time cost of this metrology step is controlled by the development of this accurate model and by the time needed for the inverse problem solving that supplies to engineers the required metrics. Conversely metrology steps are slow especially if compared to defectivity techniques that are dedicated to fast defects detection in large number of dices or on full wafers surface during the process flow. However, defectivity tools are less sensitive than metrology tools and may ignore process deviation that only metrology will detect.

In this work LTM presents a new approach for process deviation control by using metrology ellipsometers but in a defectivity way: no models and a fast deviation detection. These actions in MadeIn4 are in line with Booster 2: Smart use of data to improve the over-all productivity. This innovative strategy requires a model less approach to go faster, an automatic treatment of ellipsometry measurements that are acquired using a

raster scanning of large wafer surfaces (compared to the surface of traditional metrology dies) in order to generate images or stacked ellipsometry signatures at metrology die level and the classification or dimension prediction by deep learning algorithms. Finally, the process deviation detection or dimension prediction using this approach is benchmarked to defectivity measurements or to conventional metrology steps.
The presented results will demonstrate the augmented process deviation detection using this strategy compared to a conventional defectivity approach or to a conventional metrology approach.

Biography

Jean Hervé Tortai has been a permanent researcher at CNRS for almost 20 years. He received a PhD degree in Physics in 2000 and joined the LTM in 2002. Currently he is a team leader of the Minasee team of LTM. Since 2002, he developed ellipsometry methodologies to monitor physio-chemistry properties of ultra-thin resist films in order to optimize lithography processes. He modeled those lithography processes with a focus on E-Beam lithography to compensate for proximity effects. Another field he is involved in deals with the elaboration and the characterization of thin composite films where nanoparticles are added to tune final physical properties of the film. Since 2014, he is also in charge of the VUV Ellipsometry / MIR polarimetry chamber of the IMPACT cluster where optical properties of 300mm wafers are measured in a broadband range (145nm-12µm). Those measurements can be analyzed by modeling when metrology metrics are needed or by using a model less approach when process deviations on large surface must be detected.

Digital Twin methodology for energy modelling and management of body and assembly shop floors

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Abstract

In the speech, we explain the aim and the application of a modelling methodology for the cross topic of the Maintenance and Quality control of the plant associated with energy efficiency and thermohygrometric comfort of the industrial buildings, summarizing the achievements obtained and the ongoing tasks as contribution in the overall MADEin4 programme. Indeed, CRF has been designing and developing a digital twin enabling the energy analysis to identify some useful maintenance or energy improvement interventions. The model, once that is completed, will allow to find and test the best solutions targeting the energy performance of the industrial buildings in their obsolete parts and consequently to reduce energy consumption and to improve of the indoor air quality for a better working condition of the involved work force. The whole methodology is divided into the sections of modelling and energy analysis as follows:

- Development and test of Building Energy Management (BEM) methodology to estimate the building consumption. This methodological development has been achieved incrementally: just considering the structural parts of the buildings in the initial activity, and by integrating the PEM (Process Energy Management) data, in a subsequent refinement stage, to get the comprehensive model.
- Energy simulations to evaluate the best efficiency solution in order to reduce the consumption and to improve energy performance for a well-designed maintenance and to increase the quality of the building.

The current condition about the energy management of the factory shows greater control over the process but little attention to the energy consumed by the buildings and their maintenance and optimization. In particular, it is possible to observe:

- Lack of knowledge of the thermal behavior of the industrial buildings.
- Low diffusion of a common reference methodology for energy analysis.
- Lack of a tool to analyze in an objective way interventions on the buildings of the plant.

In this scenario the BEM+PEM methodology represents a solution for a better knowledge and control of the energy condition of an industrial building for different important factors, such as the possibility to identify the best solutions of maintenance, revamping and reduction of energy consumption, and because it allows the adoption of innovative analytics, enabling for instance the predictive quality control of working areas indoor temperatures, to the benefit and the well-being of the involved workers.

Biography

Giulio Vivo is a senior researcher of Centro Ricerche FIAT. He graduated in Information Science in 1986 and joined CRF in 1987. From 1986-1989 he worked at Tecnopolis (Bari) dealing with innovative computer vision, inspection, robot guidance, knowledge based vision systems, 2D and 3D pattern recognition applications for the FIAT group plants. He has participated in various EU RTD programs, starting with EUREKA-Prometheus. Lately he has worked in the domain of the preventive safety and the cooperative ITS systems, contributing to a significant number of projects on these subjects, the SAFESPOT EU integrated project among the others. Dr. Vivo is currently involved in the internal research activities of the Stellantis group, dealing on innovations in the process and applications of Human-Robot Collaboration, increased flexibility and reconfigurability of the automation systems, and other research and achievements for the implementation of the fabric of the future.

Giving robots and machines human-like skills to collaborate

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Abstract
As humans, we collaborate naturally. This makes us more efficient and effective.
Machines don't have this collaboration ability. By imitating the part of the human brain in charge of collaboration, we have developed a *Collaborative Social AI* platform that applies collaboration skills to robots. The platform implements innovative AI techniques including BDI mental model for Social Behavior. This enables robots to be aware of, communicate and cooperate with each other and humans autonomously.

The *Collaborative Social AI* is a plugin that can be put into any existing system or type of robot. It makes organizations that use multiple robots in their production line to be more efficient, human friendly, save time, save money.

In this talk, we will show how the Collaborative Social AI was implemented within commercial applications and will present empirical evidence of its effectiveness in deploying robust multi-robot systems, with rapid setup and development, faster production, and significantly lowered costs.

Biography
Dr. Meirav Segev-Hadad is the founder and CEO of Brillianetor, a multi-agent AI platform that endows machines with the ability to interact socially within a group. She is an inventor of novel technologies in the area of Multi-Agent Systems and is also a multi-published author in the area of AI.

Meirav has a proven record in senior management in the High-tech industry, specializing in the development of real-world applications for Artificial Intelligence (AI) in the fields of robotics, defense systems, games, and simulators.

Meirav holds a Ph.D. from Bar-Ilan University and Post Doctorate from the University of Haifa with a specialization in AI Multi-Agent Systems. She also holds a variety of patents.