Publishable Summary

The first fundamental truth of process control for the semiconductor IC industry is: ***you can't fix what you can't find. You can't control what you can't measure***[1]. The objective of the 3DAM project is to develop a new generation of metrology and characterization tools and methodologies, needed to enable the development and introduction of the next semiconductor technology nodes. To follow Moore's law[2] for the next decade, break-through developments in lithography, device architectures and new materials are needed. As nano-electronics technology is moving beyond the boundaries of (strained) silicon in planar or even finFETs, new 3D device architectures and new materials (e.g. nanowires, MX_2 and 2D materials) bring major metrology and characterization challenges which cannot be met anymore by pushing the present techniques to their limits.

3DAM will be a path-finding project (TRL 3-5) which supports and complements several existing and future ECSEL pilot-line projects such as SeNaTe and TAKE5. Innovative demonstrators (equipment and methods) will be built and evaluated within the themes of metrology and characterization of 3D device architectures and new materials, across the full IC manufacturing cycle from Front to Back-End-Of-Line (FEOL to BEOL). 3D structural metrology and defect analysis techniques such as Transmission Electron Microscopy (TEM) /tomography, 3D Atomic Force Microscopy (AFM), 3D Critical Dimension- Scanning Electron Microscopy (CD-SEM). Cathode Luminescence (CL) and advanced optical techniques will be developed and correlated to address challenges around 3D CD, strain and crystal defects at the nm scale. Compositional analysis and electrical properties will be investigated by techniques such as Secondary Ion Mass Spectroscopy ***(***SIMS), X-Ray Reflectivity (XRF), ebeam/ Energy Dispersive X-ray (EDX), micro-Raman and micro-Hall, with special attention to interfaces, alloys (III-V and SiGe) and 2D materials (MX_2). In addition, the project will develop new protocols and workflows combining different technologies for more reliable and/or faster results aiming at future integration in semiconductor process flows.

The 3DAM project relates to the MASP strategic area of Semiconductor Process, Equipment and Materials technology (7.1) especially in the More Moore area. Potential spin-offs are expected towards More than Moore technologies, while the project also has a link to the Key Application Area Smart Production (Sub-chapter 5.2: Semiconductor manufacturing). The consortium includes major European semiconductor equipment companies in the area of metrology and characterization, most of them world-leaders in their technology and major suppliers for all of the IC manufacturers in Europe, Asia and the USA. The link to the future needs of the industry, as well as critical and continuous evaluation of concepts and demonstrators, is ensured by the participation of leading Research and Technology Organizations (RTO's) **IMEC, TNO** and **LETI**, as well as chip manufacturers such as STMicroelectronics.

The impact will be significant in various areas. The project will increase the competitiveness of the strong Europe-based semiconductor Equipment industry, leading to more sales, highly skilled labour jobs and increased export to customers world-wide. The ecosystem in this field will be strengthened by incorporating several SME's and RTO's. The newly developed tools and methods will give the closely connected European IC manufacturers the opportunity to accelerate their R&D and process ramp-up and generally bring new technology nodes faster to the market. The 3DAM project will generate technologies which will be an essential cornerstone for future semiconductor processes and for the applications enabled by the most advanced technology nodes.

[1] http://electroiq.com/blog/2014/09/a-fundamental-truth-of-process-control/
[2] G. Moore, Proc. IEEE **86**, 82 (1998).