

From Research to Industrial Deployment: challenges and opportunities of the WBG Pilot Line in Europe's Semiconductors Landscape

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The accelerating global demand for electrical energy and the need for more efficient and sustainable power management systems are driving the transition beyond conventional silicon (Si) technologies. In this context, wide band gap (WBG) semiconductors such as silicon carbide (SiC) and gallium nitride (GaN) are enabling a new generation of high-power and high-frequency devices, thanks to their superior physical properties, including high breakdown field, thermal stability, and switching efficiency. These materials are already transforming strategic sectors such as automotive, renewable energy, telecommunications, transportation, aerospace, data centers, and advanced industrial systems. Despite their rapid technological progress and market penetration, WBG platforms still face important challenges compared to the well-established silicon ecosystem. Key issues remain in crystal growth, wafer scalability, defect control, device architecture optimization, reliability assessment, and cost reduction. Beyond SiC and GaN, ultra-wide band gap (UWBG) semiconductors such as gallium oxide (Ga₂O₃), aluminum nitride (AlN), and diamond are being investigated for future ultra-high-power and quantum applications. However, their limited wafer size and material quality still constrain industrial processing and large-scale adoption.

Bridging the gap between laboratory-scale research and full industrial manufacturing remains one of the most critical bottlenecks in semiconductor innovation. Intermediate development stages are often characterized by high costs and significant technological risks. In this scenario, *pilot lines* represent a strategic instrument to de-risk innovation, providing an integrated infrastructure where processes can be validated, optimized, and scaled up before mass production.

The WBG Pilot Line, funded by Chips Joint Undertaking (Chips JU) and national authorities, aims to establish a distributed European infrastructure dedicated to WBG and UWBG semiconductor technologies for power and high-frequency electronics. The initiative involves a consortium spanning seven EU countries—Italy, Poland, Sweden, France, Austria, Germany, and Finland—and brings together universities and public research centers with consolidated expertise in advanced semiconductor materials and devices.

Within this framework, CNR-IMM in Catania contributes comprehensive research activities covering the entire value chain, from materials growth to device processing and advanced characterization of both materials and devices. This broad expertise strengthens the Pilot Line's capability to address critical technological challenges and to support the transition from research outcomes to reliable and scalable manufacturing solutions.

By tackling key processing steps—from material development to device fabrication and validation—the WBG Pilot Line will refine the European roadmap for next-generation semiconductors. The know-how generated within this initiative will reinforce Europe's strategic autonomy, foster collaboration between academia and industry, create new opportunities for young researchers, and enhance competitiveness in emerging markets driven by energy efficiency and digital transformation.