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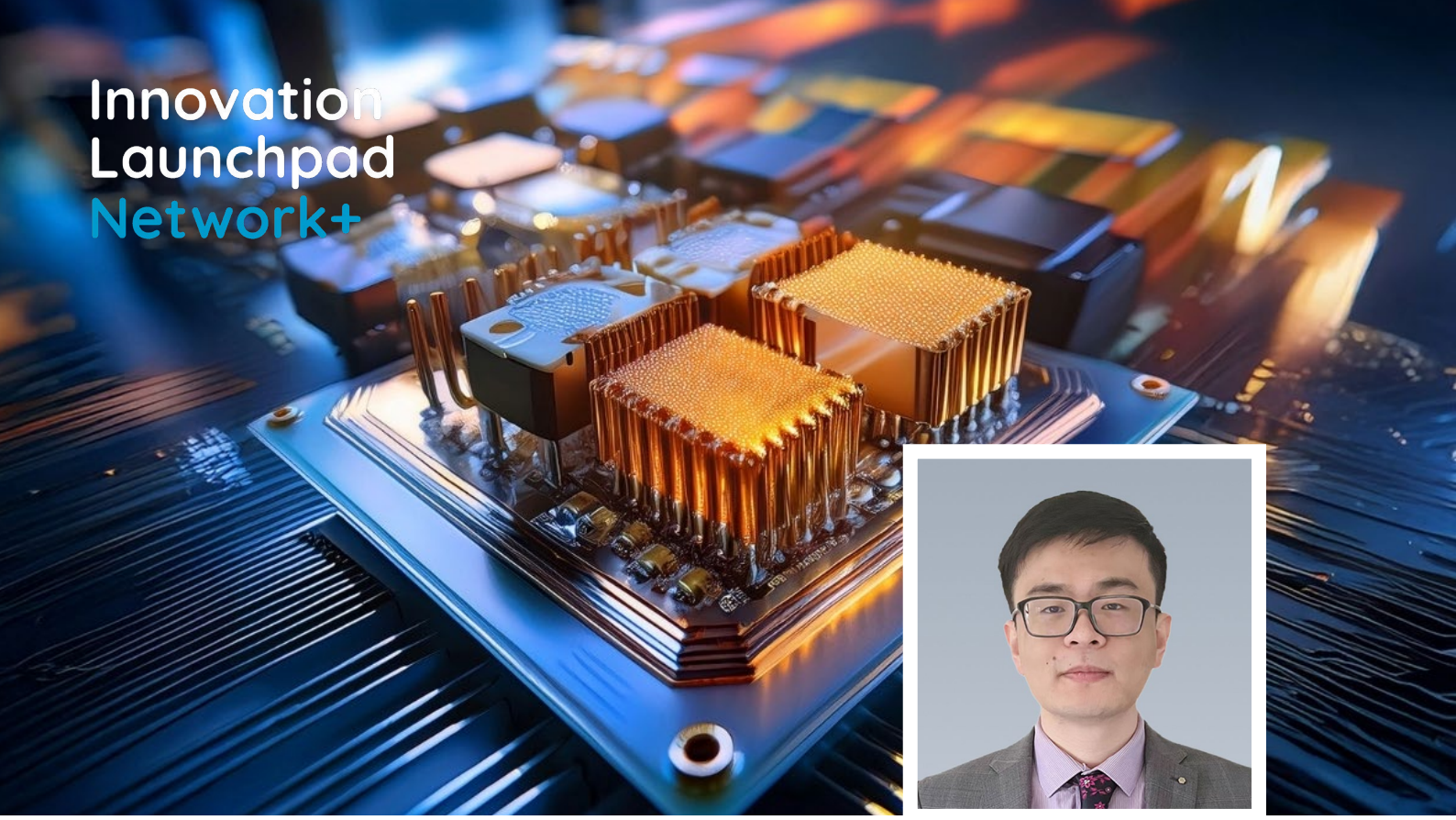

CASE STUDY

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Compound Semiconductor Applications (CSA) Catapult

The Challenge

The primary challenge addressed in the project was the under-researched thermal performance of Gallium Nitride (GaN) transistors, which are critical for efficient and compact power electronics applications such as electric vehicle chargers and renewable energy systems. GaN transistors offer superior performance to traditional silicon devices, such as fast switching, but potential overheating compromises their reliability and limits their broader adoption. This challenge was composed of the need to develop precise, non-invasive methods to measure and model thermal behaviour. Furthermore, fast and accurate design optimisation of GaN power converters is also challenging, and further investigation of accurate GaN models and suitable optimisation approaches is needed.

CATAPULT Compound Semiconductor Applications

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Innovation

The project addressed these challenges by developing a non-invasive, accurate, and fast measurement technique to explore the link between temperature-sensitive electrical parameters and junction temperature in GaN devices. It also introduced new methods for efficient and precise thermal characterisation to better understand the thermal performance of these devices. Building on this, the team developed an AI-driven design approach to identify solutions that improve power efficiency and increase power density in GaN-based converters.

Result

The project delivered key advancements in GaN transistor thermal management and design optimisation, tackling critical gaps in the field. It developed a precise, non-invasive, and scalable method for characterising the thermal behaviour of GaN transistors during fast-switching transients — pushing beyond the limitations of conventional Silicon-based systems. This innovation improves device reliability and supports the wider rollout of GaN technology in Net Zero applications. The team also created AI-powered simulation models and intuitive design tools that help optimise power converters. These platforms encourage knowledge sharing and are valuable for both industry and academic users, enabling the scalable adoption of next-generation GaN technologies. Project outcomes were shared widely through open-access publications, including papers in leading journals and presentations at international conferences such as PEMD 2024. Notably, the collaboration played a part in securing two new funded projects and helped grow networks between Cardiff University, CSA Catapult, and industry partners — setting the stage for future joint work. On the educational front, project insights have been embedded into Cardiff University's Power Electronics module, benefiting 50–100 students each year.

Impact

The project has made a strong impact across several key areas. It has pushed forward the understanding of GaN thermal characterisation through rigorous testing and advanced modelling, directly supporting the creation of more efficient and reliable GaN-based power devices. These are crucial for sectors like renewable energy, electric vehicles, and consumer electronics. Through close collaboration between the Researchers in Residence (RiR) programme and CSA Catapult, the team achieved valuable knowledge exchange. Results have been shared through publications and conferences, reaching both academic and industry audiences. The partnership also encouraged cross-disciplinary collaboration, laying the foundation for future joint ventures in GaN research. The project's success has sparked opportunities for follow-on work, especially in areas like battery energy storage and hydrogen fuel cells. Developing advanced GaN models and AI-driven tools for GaN power converters has provided a solid base for future innovation. Team members also gained practical software and hardware design skills, boosting their readiness for careers in industry. Access to state-of-the-art facilities and tools demonstrated the project's drive to push technological boundaries. Overall, the outcomes are helping to inspire improvements across the electronics sector, supporting the development of more sustainable devices and advancing the shift towards cleaner, greener energy solutions.

CSA Catapult

“Collaborating with Dr. Sheng Wang increased CSA Catapult’s capabilities in the GaN power devices’ thermal study and AI-driven design optimisation of converters. This partnership bridged academic insights with industry applications, fostering wider professional networks in power electronics.”

Sheng Wang

“This project has been a transformative step in advancing thermal characterisation and modelling of Gallium Nitride transistors and AI-driven tool for design and modelling GaN converters. Collaborating with CSA Catapult bridged academic research and industry, creating innovative solutions based on compound semiconductors that support Net Zero goals and empower future engineers to drive innovation in power electronics.”

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