

## **Expanding the Prospects of Development and Production of Modern Batteries through Laser Technologies**

**Wilhelm Pfleging**

Professor

Group Leader-Laser Technology/Lithium-Ion Batteries  
Institute for Applied Materials (IAM-AWP)  
Karlsruhe Institute of Technology (KIT)  
Germany



**Abstract:** Laser technology is paving the way to modernize and increase the efficiency of battery production processes, preparing them for the next generation of high-performance batteries. Initial concerns about integrating lasers into battery and module manufacturing have dissipated, and already laser-assisted processes have replaced conventional methods, significantly improving production efficiency and quality. For instance, laser welding has become the dominant process in module manufacturing, replacing traditional joining techniques, such as resistance spot welding. A similar transformation is expected for laser cutting, notching and slitting of electrodes. Developed in the last decade, laser cutting is becoming increasingly important for separating electrodes due to its improved cutting-edge quality. Technological advances in high-power fiber lasers, blue diode lasers, and ultrashort pulse lasers open the future prospect of increased laser use in battery manufacturing. While laser cutting and welding replace conventional methods and improve production efficiency without altering battery properties, laser-assisted development of 3D electrodes is being developed to significantly and specifically increase electrochemical performance, opening new perspectives for long lifetime as well as high-power and high-energy battery systems. The 3D battery concept provides access to new electrode designs with optimized diffusion kinetics and wetting behavior and reduced mechanical degradation. Laser printing and ablation complement each other in the development of those 3D electrode architectures. This presentation highlights optimized 3D electrodes that enhance battery lifetime, high-charge capability, energy and power density, and safety by minimizing lithium plating during fast charging.