Advancing Battery Ultrasound Inspection: Contact-Free Solutions through Laser-Excited Acoustics

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The rapid growth of electric vehicles has intensified the demand for reliable battery technologies. Ensuring safety and high-performance of batteries and battery cells is paramount, necessitating innovative non-destructive testing techniques. In response, we present a pioneering approach, focusing on the use of laser-excited acoustics and contact-free ultrasound signal detection (abbreviated as LEA) for various demanding battery inspection tasks. Ultrasonic testing is a widely favored and established inspection technique in industries such as Aerospace and Oil & Gas. However, its application within the battery segment has been less pronounced, primarily due to constraints imposed by conventional techniques. Traditional ultrasonic testing methods rely on contacting the sample through pressure-contact or water-/liquid-coupling. These methods can impose limitations in terms of cycle time, automatability, reproducibility, and further usability of the inspected part. Conventional air-coupled ultrasound solutions overcome some of these limitations, but at a significant expense of resolution and detection frequency bandwidth. The presented laser-excited ultrasound inspection method features a unique combination of high automation capability, no necessity for contacting or contaminating the test component and high-resolution imaging with a bandwidth of up to 4 MHz in air. In this presentation we will showcase results from comprehensive testing campaigns conducted at multiple stages along the battery manufacturing value chain: detection of electrolyte distribution after filling, defect detection in pouch cell sealings, verification of uniform thermal paste distribution, and lack-of-fusion inspection on bus bar welds. The water-free, non-contact approach of this high-resolution ultrasound method makes it an optimal candidate for inline, automated quality control in mass production environments.