Experimental and theoretical study of laser cutting on electrodes for lithium-ion batteries

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Abstract

Laser cutting has been used for various applications such as microelectronics, nanoscience, automotive, aerospace, and ship building since its developments. Applying laser cutting on electrodes for lithium ion batteries is relatively new application. Conventional cutting methods such as rotary knife cutting and die cutting may result in critical problems due to the tool wear. Tool wear leads to process instability so that cut quality may be degraded suddenly. Poor cut quality may penetrate separator and the protrusion of separator results in an internal short circuit. Furthermore, electric stress can be locally concentrated. Therefore, this electrical stress concentration may cause battery explosion. In addition, the frequent change of battery cell design increase manufacturing cost significantly. Due to the above-mentioned problems, laser cutting is suggested since it has many advantages such as non-contact process, high energy concentration, flexibility to cell design change, and no tool wear. Although laser cutting is becoming a promising solution in the electrode cutting for lithium-ion batteries, few theoretical studies have been done. Furthermore, few number of systematic experimental studies was reported. Therefore, this study will present experimental and theoretical examination of laser cutting on electrodes for lithium-ion batteries. Maximum cutting speed and surface morphology are observed as well as a melt pool visualization method during the cutting process are suggested experimentally. Moreover, 3D self-consistent mathematical model is proposed and underlying multi-physical phenomena is discussed.