Effect of organic solvent additives on the enhancement of ultrasonic strength in water for lithium ion battery electrode delamination

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Abstract

Ultrasonically-assisted delamination is an energy saving process for direct recycling of spent lithium-ion batteries (LiBs). A typical LiB cathode consists of active lithium metal oxide crystal compound coated on an aluminium foil, the current collector, at a thickness of ~100um. The lithium metal oxide compound contains valuable transition metals, such as manganese, nickel and cobalt. The first step of recycling of spent LiBs is to separate the electrode coating from the aluminium foil. In ultrasonic delamination process, the vigorous acoustic waves and cavitation-mediated effects are proved to be the mechanism in fast delamination of LiBs electrode (Figure 1). The efficiency of the ultrasonic delamination relies both on the solution in which the delamination process is carried out and the power of the ultrasonic system.

In this work, organic solvents of Ethylene Glycol (EG) and Glycerol (Gly) are added to water in varying concentrations and sonicated under a 20 kHz ultrasonic horn at varying input powers. The effect on both the cavitation and overall LiB cathode delamination are monitored. Acoustic measurements via hydrophone and corresponding high-speed imaging of the delamination process are undertaken in each solution to assess the effect of an organic solvent and its concentration in water. The study investigates the effects of viscosity, surface tension and vapour pressure of the water-based solution on the cavitation intensity and overall delamination strength. This study is useful for optimizing solution composition for application in ultrasonically assisted delamination.

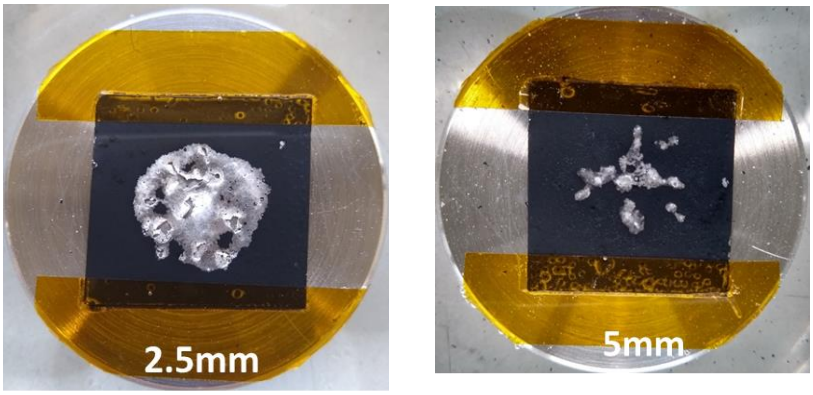

Figure 1: ultrasonic delamination of a lithium-ion battery cathode in 3 seconds, at a distance of 2.5mm and 5.0mm beneath the horn tip.