Exploring Deformation-Driven Short-Circuit Mechanisms in Li-Ion Pouch Cells Using In-Situ Synchrotron Laminography

Thomas Tancogne-Dejean*†[1], Vincent Grolleau , Simon Bode , Matthias Hurst , Thilo Morgeneyer[2], and Dirk Mohr

[1]Chair of Artificial Intelligence in Mechanics and Manufacturing, ETH Zurich – Switzerland
[2]Mines Paris - PSL (École nationale supérieure des mines de Paris) – Centre des Matériaux (CMAT), CNRS UMR 7633, BP 87 F-91003 Evry Cedex – France

Abstract

Lithium-ion cells are complex mechanical systems with poorly understood failure mechanisms under mechanical loading. Independent of their application (e.g. portable electronics or automotive), all cells are made of the same repetitive layers of anode, cathode and separator. Both electrodes are made of metallic foils coated on both sides with a granular media. A liquid electrolyte ensures ion transfer through a porous polymeric separator. From post-mortem investigations it is known that under out-of-plane indentation, localization bands are formed below the indenter. Failure of the separator leads to a short circuit and thermal runaway. At the same time, ductile failure of the individual current collectors is also reported. In this study, we investigate and quantify the failure mechanisms in commercial small-format pouch cells (4Ah capacity with NMC/graphite chemistry) using in-situ synchrotron laminography. A newly-developed dedicated loading frame enables performing macroscopic hemispherical indentations. Two in-situ indentations are performed, one with high-quality and one with high field of view. Both comprises more than ten loading steps. In both cases, the voxel size is 3.25μm. The failure in each component is then assessed and quantified through phase segmentation. This insight will help develop numerical model of lithium-ion cell and further enable the design of safe battery system.

*Speaker
†Corresponding author: thomatan@ethz.ch

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