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Time-resolved phase evolution during creation of nanoporous Cu current collectors by a dealloying approch

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Dealloying is used to fabricate nanoporous metals, and is a process where less noble components (e.g. Al) in the precursor (e.g. AlCu) are dissolved, leaving the nobler elements (e.g. Cu) to a nanoporous structure. Nanoporous Cu is desired in lithium-ion batteries as current collectors, which can provide large surface area for active materials. From the perspective of phase evolution, it was reported that only Al-rich phase (e.g. fcc alpha;-Al(Cu), tetragonal Al₂Cu) can be dealloyed completely to form fcc Cu, but not Cu-rich phase (e.g. monoclinic AlCu, cubic Al₄Cu₉) placing limitations in creating nanoporous Cu.

To further understand it, we carried out in-situ and ex-situ dealloying experimentation at synchrotron powder diffraction beamline. We selected two two-phase Al-Cu precursors (at.%): Al55Cu45 (Al₂Cu and AlCu) and Al45Cu45 (AlCu and Al₄Cu₉) alloys. The time-resolved phase evolution results showed that, in all three cases, the dealloying of two phases started in sequences with the formation of Cu. The dealloying of the relatively Al-rich phase (e.g. AlCu in Al45Cu55) started preferentially and subsequently it would promote the dealloying of relatively Cu-rich phase (e.g. Al₄Cu₉ in Al45Cu55). This study improves the understanding of dealloying of AlCu and demonstrates the capability of creating more nanoporous copper via multiphase precursor designing.

Keywords

dealloying; nanoporous; in-situ; phase evolution; multi-phase designing

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