ABSTRACT: This research focuses on increasing the available capacity for lithium and sodium ion batteries by seeking to improve the stability of alloying-type anode materials. Enticed by the high theoretical capacities of alloy anode materials such as Si and Sn, we explore different methods to stabilize these materials and alleviate damage induced by the significant volume expansion that results from the accommodation of such vast quantities of Li+/Na+ ions. To meet this goal, we utilize several stabilizing techniques, such as the design and formation of nanoporous architectures and use of multicomponent alloy systems. 2D transmission X-ray microscopy is used to image these particles in-situ, in order to elucidate the cycling behavior of these materials during typical battery cycling. We specifically focus our attention on two systems, Sb and an SbSn intermetallic alloy, in order to evaluate the individual and synergistic stabilizing contributions of nanoporous architectures, multicomponent alloy anodes, and amorphous intermediates. In doing so, we highlight the need for a more advanced 3D imaging technique. To address this, we describe a novel battery cell geometry specifically designed and employed for the gathering of in-situ 3D tomography data, which can be then reconstructed into detailed 3D models of our particles for further analysis.