Designing Composites, All Solid-State Battery Devices, and Densification of Powder Metal by Cold Sintering Process


Cold sintering is a newly introduced chemo-mechanical aid densification phenomenon driven by pressure solution creep, which has enabled the processing of ceramics and ceramic composites at temperatures that had previously not been realized. Thus, it opens multiple new ways to integrate different materials and to obtain new properties. In our studies, we use moderate temperatures and pressures, with reactive transient chemistries to drive the densification in thousands of seconds, as we point to the applicability of the pressure solution mechanisms that drive the cold sintering in a functional material. This is demonstrated within a pressure solution model and accounts for the kinetics and scale of the grain facet microstructural development.

Cold sintering of metals utilizes surface modification of powdered metals. This typically includes the deposition of a specified coating over individual particles. This coating promotes particle rearrangement and acts like a glue to form a co-continuous layer between individual particles, resulting in high-strength systems.

Using the cold sintering process, the fabrication of novel composites can be made to provide new properties and new functional devices. Here, we outline multiple different concepts that can influence properties impacting dielectric- and ferroelectric-based materials, along with energy storage designs in electrochemical-based functional materials to demonstrate the broad impact of this discovery across multiple materials and application areas, such as new high voltage-high permittivity dielectrics, designed dielectrics with high frequency and high thermal conductivity, and sophisticated composites with hierarchical structures and low impedance interfaces of ASSBs.