

Machine Learning–Enhanced Simulation and Optimization of Ceramic Sintering Processes

Sintering is one of the most critical stages in the ceramic manufacturing cycle, as it strongly affects the final properties and quality of ceramic products. The development of controlled process technologies for optimizing firing protocols and reducing production waste is therefore essential for modern ceramic manufacturing.

In this work, a novel process technology is presented that enables the entire sintering process to be virtually modeled, analyzed, and optimized through the combination of classical numerical simulation techniques and artificial intelligence methods. The proposed approach integrates multimodal heat transfer modeling within the oven with the prediction of the shape evolution during sintering. This is achieved by coupling physics-based simulations with Physics-Informed Neural Networks (PINNs). Based on this framework, comprehensive optimization of both the sintering process and the topology of the ceramic components can be performed. Optimization objectives include the reduction of waste through minimization of stress concentrations, shortening of process times via optimized firing schedules, and improvement of green body design while accounting for sintering-induced deformations. The model requires only readily accessible material parameters, such as density and porosity measurements of test specimens, results from three-point bending tests, grain size distributions, and the pyroplastic index.

Professional Status of the Speaker

Senior Scientist

Interest in submitting a paper in a special issue of

Advanced Engineering Materials (Wiley)

Invitation letter for visa

No

Author: LANDGRAF, Jens (sico-solutions scientific and technical solutions)

Co-authors: Dr ELASMI, Mehdi (sico-solutions scientific and technical solutions); Dr HOFFMANN, Wolfgang (sico-solutions scientific and technical solutions)

Presenter: LANDGRAF, Jens (sico-solutions scientific and technical solutions)

Session Classification: Modelling and simulation of sintering at multiple scales

Track Classification: Group 1: Modelling and simulation of sintering at multiple scales