

In-Situ Informed Data-Driven Modelling of Fast-Firing Liquid-Phase Sintering of Aluminosilicates

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The evolution of microstructure, reaction kinetics, and thermal and mass transport is tightly coupled when designing industrial sintering programs. For aluminosilicate systems, used for white-tiles and structural ceramics, densification is highly sensitive to local heterogeneities and thermal phenomena near the onset of liquid-phase formation. Under fast-firing conditions, high heating rates and short dwell times prevent local thermal-equilibration, influencing liquid-phase flow, pore-network percolation and decomposition reactions. While macroscopic kiln simulations were performed, the microscale activation of densification mechanisms and their upscaling into constitutive models are insufficiently understood [1]. Recent in-situ studies provide valuable insights but remain descriptive [2]. This work presents a data-driven framework that derives densification models from quantifiable in-situ experiments. Micrographs acquired via high-temperature environmental SEM (ESEM) of α -Al₂O₃ and soda-lime-silica glass samples at fast firing conditions are analyzed using automated image-analysis to quantify neck growth, particle rearrangement pore closure and liquid formation. The extracted descriptors are correlated with mass spectrometry and DSC-TGA data and implemented in a Dyssol flowsheet-simulation [3] to upscale sintering densification kinetics into stage-resolved industrial kiln models.

[1] Alves et al., JACerS 2023 [2] Bigeard et al., Materialia [3] Skorych et al., SoftwareX 12

Professional Status of the Speaker

Doctoral or Master Student

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