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ABSTRACT:

Flash Sintering of Oxides: Is it Just Joule Heating?

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Flash sintering is a novel processing method capable of densifying ceramics in seconds. It is a member of an entire family of field-assisted sintering techniques, which induce high heating rates and cause faster processing times at lower processing temperatures. For most such methods the high heating rates are caused primarily by the Joule heating of a high electric current passing close to the sample (e.g. through a graphite die surrounding the sample). During flash sintering, however, the entire electric current is forced to pass through the sample body itself. As such, a central question of the research field is: Is the rapid densification induced by flash sintering also directly explainable Joule heating, or is it dependent on additional athermal effects, which are caused by the current passing through the sample?

To date, evidence points towards a predominantly Joule heating-based mechanism. However, several contradicting experimental observations appear to directly necessitate athermal effects. In the presented work, we several such observations which were previously strongly linked to the existence of athermal effects at different stages of flash sintering across a range of oxide materials including transition metal oxides and perovskites. We demonstrate that the experimental findings are consistent with a purely thermal mechanism in all examined cases, resolving the apparent contradictions.