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FIELD AND THERMAL FACTORS IN FIELD-ASSISTED CONSOLIDATION OF POWDER MATERIALS

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Possible thermal and field factors, which may influence densification during spark-plasma sintering (SPS), are considered. Two experimental setups revealing the role of both groups of factors for SPS processing of conductive and semi-conductive materials are described.
To de-convolute the influence of the electrical current, spark plasma sinter-forging experiments are conducted to compare the constitutive behavior of a copper powder under current-insulated and current-assisted SPS process conditions. The processing mode with specimen's free lateral surface enables the direct in-situ measurement of the powder material temperature. The experimental results are interpreted in the framework of the developed constitutive model of the spark-plasma sintering of conductive powders, taking into consideration thermal and non-thermal factors. The micro inhomogeneity of the temperature distribution and its effect on the densification rate of conductive powders during current assisted sintering is analyzed.
The role of thermal factors is displayed by a developed method for conducting flash spark plasma sintering (SPS) type experiments with an industrial SPS device. The effectiveness of this technique is studied for consolidation of SiC powder. Specially constructed dies are designed to heat the pre-compacted SiC powder specimens to a critical temperature before applying any voltage to the specimens. The dies incorporating a sacrificial metal bushing heat the specimen allowing the electrode-punch of the SPS device setup to contact the specimen and pass current through it under elevated temperatures. The experimental results demonstrate that flash sintering phenomena can be studied using conventional SPS devices. The role of the thermal runaway phenomena for material processing by flash sintering is theoretically analyzed. It is shown that the thermal runaway may affect the scalability of the powder consolidation.