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NUMERICAL MODELING OF CERAMICS SINTERING AND MELTING BY MICROWAVE HEATING

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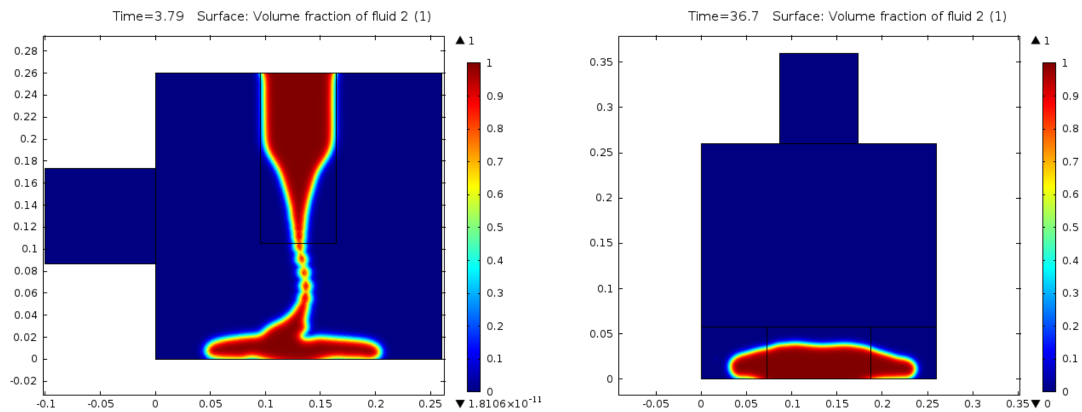
Different industrial material processes that use conventional heating are starting to be substituted partially or completely by microwave heating, which is responsible for a volumetric heating. This means that materials can absorb microwave energy directly, internally and convert it to heat. It is this characteristic that leads to advantages over conventional heating such as: high speed startup, selective energy absorption, instantaneous electric control, high energy efficiency and high product quality, see e.g. the reviews [1, 2, 3].

One important tool to study and optimize these processes is through the use of numerical simulations. This approach presents several challenges: from the coupling of the different modeling equations, to the tracking of the unsteady melting flow during the simulation and the sintering phenomena of the ceramic materials.

In this work, the COMSOL multiphysics software is used to couple the Maxwell equations (microwave), the energy, continuity and momentum equations. A two-level set approach is used to simulate the interface between the ceramic material and the air. Additionally, a melting model based in the Metzner method [4] was created in the computational case. The sintering modeling is done by using a densification law similar to the one used by Bouvard *et al.*[5].

To show the different capabilities of the developed approach, results with both conventional and microwave heating are presented. The case with conventional heating shows that the model can have different unsteady melting motions by modifying the source term function of the energy equation. Finally, the case with microwave heating is done for a idealized cavity where a small parametric study was conducted, showing the characteristics of the proposed numerical model.



(a) Conventional heating example.

(b) Microwave heating example.

Figure 1: Examples of the implemented numerical model.

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