

## PATTERN FORMATION DURING CURRENT SINTERING (SIMULATION)

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Current sintering is becoming increasingly important for creating nanostructured materials from powders. Joule heating inside the sample enables the rapid densification necessary to preserve the nanostructure. However, the presence of electric fields and currents activates additional effects, such as inhomogeneous grain-growth and coarsening, thermoelectric effects, as well as dopant migration. In return, these effects influence the transport properties of the material during sintering which constitute feedback mechanisms that, ultimately, can lead to the formation of patterns.

The Winterer group observed such pattern formation in Al-doped ZnO. The material is prepared with an Al-concentration above the solubility limit which leads to precipitation when the material is sintered. Only during current sintering distinct layers of different porosity and precipitate concentration form. Because of the complex intertwining of transport processes, we study two complementary aspects. On one hand, we investigate the influence of precipitates on Joule heating. Our results show that reduced conductivity due to precipitates yields patterns perpendicular to the electric current (cf. Figure 1a). On the other hand, we study migration of anions and cations in a reaction-diffusion model. Here, we propose as feedback mechanism a precipitate-dependent ion mobility. This, too, leads to patterns (cf. Figure 1b) which are qualitatively different from the Joule heating case. Both models have in common that random fluctuations trigger the emergence of the patterns.

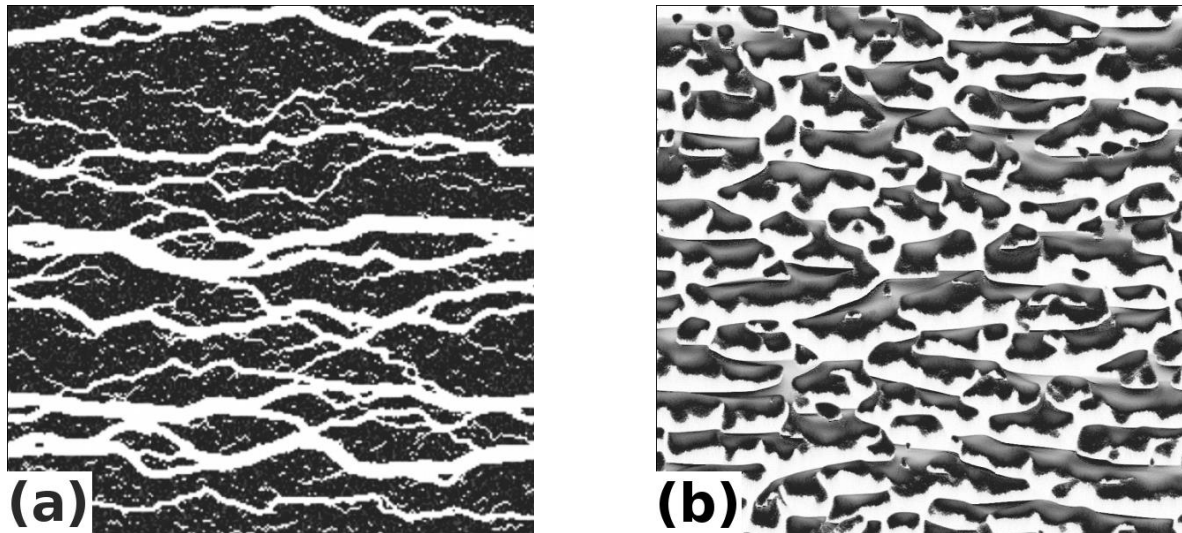


Figure 1 – Precipitation patterns obtained from (a) Joule heating (local conductivity is color-coded) and (b) precipitate-dependent ion mobility (precipitate concentration is color-coded).