EPM activities at SIMaP : focus on Solar Silicon elaboration

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TOPICS : 2. Induction heating, plasma processing & related heat treatment ; 6. Solidification, crystal growth under external fields, EM casting

Electromagnetic Processing of Materials (EPM) is studied in SIMaP for applications in nuclear engineering and in the energy sector. Our research concerns the effect of electromagnetic fields on fluid flows, mass transfer and materials micro structures. The fluids on which we act are mainly liquid metals (including molten semiconductors), but also oxides (to be solidified as glass or crystals), or gases (thermal plasmas). A survey of those activities will be presented.

Focusing on two examples concerning solar silicon, we'll present a plasma purification process and studies on the segregation of impurities during solidification. The plasma used to remove boron from liquid silicon is provided by high power (40 to 600kW) induction torches, that were studied both numerically and experimentally as a EPM system acting on gas [1]. When the segregation phenomenon is used to remove metallic impurities from the silicon, a strong stirring improves the productivity, and our studies (experimental and numerical) enable to quantify this performance [2].

Electromagnetic stirring of liquid silicon is also used in the plasma process and generally can be viewed as a means to increase the mass transfer to interfaces (free surface or solidification fronts), raising several questions about turbulence and magnetic fields, complicated by free surface deformations or flow across the solidification front. Some other open questions arise from the impurity distribution in solidified silicon, that do not always follow the classical Scheil law when metallurgical silicon is used in segregation processes.

References

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2. M.Cablea,K.Zaidat,A.Gagnoud,A.Nouri,Y.Delannoy*, J. Crystal Growth* **401** (2014) 883-887