Contribution ID: **148** Type: **PICO talk**

Brownian ratchet model - particle and ice front interaction

Tuesday 9 January 2018 12:35 (1h 30m)

When a moving solidification front encounters a foreign particle in the melt for example during freezing, it can either engulf it, or push and reject it. This interaction takes place in freezing of any colloidal suspension and is basic in metallurgy, freeze casting, frost heave, and cryopreservation. In this work we show that the interaction of the particles with the freezing front can be explained by displacement of the particle that undergoes Brownian fluctuations near a moving wall which is the freezing front. Movement of the ice front limits the space where the randomly fluctuating particle can diffuse, resulting in a ratchet mechanism that allows the particle to move only in the direction of the growth of the ice. The model reproduces the known and established result that the critical velocity for engulfment scales as 1/(n r), where n is the viscosity of the fluid and r is the particle radius. The Brownian ratchet model also explains the independence of the critical velocity on the particle size, for small particles, which was observed in early work in the field. Numerical simulation based on our model predict that the dragging distance of the particle being pushed by the ice front scales as exp(1/v r) where v is the ice growth velocity. Experimental data obtained by us and published by others is in agreement with predictions of our model.
The scaling of the dragging distance for a single particle, once developed for a multi particle system can allow the calculation of the length scales of patterns being formed during freezing such as ice lenses and freeze casting.
This work was supported by a grant from the Israel Science Foundation and the Rudin fellowship.

Significance statement

We present a novel and intuitive model explaining the particle rejection phenomenon. It explains existing data and predicts the particle dragging distance by the ice front. Model implication to multi-particle systems can be the framework to develop a theory explaining the length scales in patterns formation during solidification.

Author: Mr CHASNITSKY, Michael (The Hebrew University of Jerusalem)

Co-authors: Prof. BRASLAVSKY, Ido (The Hebrew University of Jerusalem); Dr YASHUNSKY, Victor (Institut Curie, Paris)

Presenter: Mr CHASNITSKY, Michael (The Hebrew University of Jerusalem)

Session Classification: Poster & Lunch