IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Interactive Presentations - IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (IP)

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THERMOELECTRIC CONVECTION IN A RECTANGULAR CAVITY

Abstract

We examine the flow behaviour when a thermo-electro-hydrodynamic force is applied between two plates by means of an AC voltage and a temperature gradient. Thus, the temperature dependence of the electric permittivity leads to dielectrophoretic (DEP) force that acts as a buoyancy force between the plates. The DEP force increases with the increase of the amplitude of the high voltage and, with the decreasing of the gap distance between the plates. Under Earths condition this artificial force field only disturbs the stability of the flow formed in the normal gravity due to temperature difference. Under microgravity, the natural force field of the Earth is too weakened (¡ 10-2g), and the force field produced across the gap by the high voltage is then the only acting source in the development of the convective motion. In the experiments, we are focused on two aspects: on one hand we want to visualize the flow and on the other hand to measure the heat transport. The parabolic flight experiment provides a contribution to study the effectiveness of the artificial force field and give hints for technical applications. The rectangular cavity cells are designed for Particle Image Velocimetry measurements, but, other optical measurement techniques like the Shadowgraph method may also be applied. The experimental goals with the rectangular cavity are the identification of convective flow and their dependency on the experimental parameters, the measurement of the resulting heat transfer and the impact of the non-contributing boundaries. This experimental work is complemented by theoretical and numerical studies which provide a better insight into the flow control under the effect of electric fields and temperature variations. As the DEP force increases when the gap decreases, it opens new perspectives for applied microfluidics and can be useful for the development of devices like micro-pumps, micro-mixers and micro-heat exchangers, without moving parts (no fan, no pumps), and thus providing an improved reliability. Furthermore, DEP force allows the design of devices with controllable heat transfer.