MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

Author: Dr. Satoshi Matsumoto
Japan Aerospace Exploration Agency (JAXA), Japan

SIGNIFICANCE OF MICROGRAVITY EXPERIMENT OF MARANGONI CONVECTION ONBOARD THE ISS

Abstract

An interface between liquid and gas has a surface tension due to attractive force of molecules at the surface. The strength of a surface tension deeply depends on a temperature or a concentration of mixture. When the surface tension gradient by temperature difference exists along the interface, the surface is pulled from hotter side toward cold side. This becomes a driving force of Marangoni convection. When the driving force becomes stronger, convective motion transit from steady to oscillatory, chaotic flows. And finally, a significant turbulence would be lead. These transition phenomena comes from the nature of convective instability. It is very important to produce the transition map to contribute not only the advance of fluid dynamic but also industrial application. On the ground, Marangoni convection tends to mask with buoyancy flow. In order to observe pure Marangoni convection, microgravity environment is preferable because buoyancy convection would be remarkably reduced. From 2008, Japan Aerospace Exploration Agency (JAXA) had started the scientific experiment of Marangoni convection. Experiments are continuously performed at 2016. Marangoni research group produces a lot of significant results. At first, they made clear the characteristics of Marangoni convection induced in a liquid bridge configuration. The non-dimensional parameters governing Marangoni convection are the Marangoni number (Ma), Prandtl number (Pr), aspect ratio (AR), volume ratio (VR). The effect of these parameter on onset of oscillatory flow was clarified. In addition, the transition process to a chaotic convection was investigated based on the temperature fluctuation at the free surface. The last remaining of governing parameter is Biot number (Bi). Bi represents a simple index of the ratio of the heat transfer inside of and at the surface of a liquid bridge. Recently, the effect of Biot number on the transition phenomena are pointed out to be surprisingly large. Final microgravity experiment of Marangoni convection on the ISS will study on the Biot number effects. This experiment should give the knowledge with respect to the control of convection. It might contribute to wide range of application such as a high quality crystal growth, steel manufacturing, printable electronics, microfluidics and so on.