Melt mixing and solidification process of In/GaSb/Sb compound semiconductors under microgracity

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A mixing experiment of multicomponent melts was performed using a uniform temperature furnace in the Second Internationl Microgravity Laboratories (IML-2) mission. To clarify the role of the Marangoni convection and the molecular diffusion, four samples with free melt surface and two samples without surface were used. The combination of source materials was made of Sb-GaSb-In sandwich structure so as to become InSb, $In_{0.5}Ga_{0.5}Sb$ and $In_{0.3}Ga_{0.7}Sb$. These samples were heated up to 733 ℃ in space and 744℃ on earth, and then cooled rapidly.

The sample with free surface grown under microgravity was nearly spherical in space, except some parts with projections. Ga was dispersed homogeneously in the bulk because the mixing was enhanced by Marangoni convection due to concentration gradient. On the other hand, the sample grown on earth was a double cylindrical shape with different diameters, and Ga concentration decreased from top to bottom, showing clearly the effect of gravity.

In the case of the sample without free surface, the melt mixing in space was controlled by diffusion which was represented with the combination of error functions, and the diffusion coefficient of indium was given by a value of $3.5 \times 10^4 (cm^2/s)$. In the earth sample, however, the indium concentration distribution followed an exponential curve. This indicated that both factors, diffusion and natural convection, have contributed to the mixing of semiconductor melts.

From the result obtained, the contribution of Marangoni convection and diffusion on the melt mixing was made clear.