Gravity effects on crystal growth of III-V compound semiconductor

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The thesis describes an influence of gravity on crystal growth of semiconductor. InGaSb and InP compound semiconductors were chosen as research materials. The view pointwas focused on the solution formation process in the former system, and vapor species transportation process in the latter one. The crystal growth experiments were executed in microgravity(μG) environment by a recoverable satellite, a sounding rocket and a Space Shuttle, and in addition they were done on earth (1G). Furthermore, the experimental results were confirmed by numerical simulation.

A cylindrical GaSb/InSb/GaSb structure was contained in a quartz ampoule and heated up to the melting point of InSb. The GaSb was dissolved into the InSb melt. The interface between the solid and the solution was evaluated. The interfaces of the μG sample performed in the satellite were almost flat along the radial axis. However, the interfaces of the 1G sample were distorted along the gravity direction by convection caused from concentration difference.

S-doped and Fe-doped InP wafers were introduced into a quartz ampoule with transport agent of $InCl_3$. After temperature gradient was applied to the ampoule, InP epitaxial layer was grown and the thickness distribution was measured. The μG sample of a Space Shuttle had a higher thickness uniformity with diffusive transport. Contrarily, the 1G sample had non-uniformity which was caused by convective flow of vapor species.

Crystal growth processes are highly influenced by gravity in both of solution and vapor system.
Therefore it is concluded that the suppression of convective flow was a key condition for high quality crystal growth.