Activity Report

Visiting Prof. Thierry Duffar

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Growth kinetics at crystal/melt interface

The objective of the Visitor's research is to develop a model to predict phenomena occurring at the crystal/melt interface of semiconductor materials during their unidirectional solidification. Prof. Fujiwara's group at IMR provides experimental results about the kinetics at the crystal/melt interface of semiconductors such as Si or GaSb. These results are obtained by real-time in situ observations thanks to their unique equipment allowing video recording of the solid-liquid interface behavior at various growth rates. By combining these experimental results with our theoretical analyses, we can expect to deepen the understanding of semiconductor crystal/melt interface kinetics.

In FY 2020, it has been difficult to visit IMR due to the COVID-19 pandemic. Instead, we were able to have meaningful discussions via web seminars. In this seminar, we provided guidance on student presentations, which was a good opportunity for students to improve their presentation skills.

First, we discussed about the grain boundary kinetics at the crystal/melt interface of Si. It was clearly observed that small angle grain boundaries are formed at the crystal/melt interface due to the aggregation of dislocations during unidirectional solidification. Split of small angle grain boundary was also observed. We discussed about the possible mechanisms based on the strain energy associated to the elastic field surrounding the dislocations. It was suggested to perform experiments under various growth rates but same temperature gradient.

Secondly, we discussed the production of LB4 crystals with a periodic twin structure and their application to light conversion devices. An original and unique technique for producing LB4 crystal with a periodic twin structure was presented. This method utilizes the ease of twinning in the crystal growth process of LB4, and is expected to be used for wavelength conversion devices on non-dielectric materials. It was suggested that looking for possible periodic eutectic structures could help to produce such materials.

Thirdly, we discussed about the growth of Si clathrate crystals obtained by Na flux method. It was shown that type I and type II clathrate crystals can be produced separately by controlling the growth conditions. It was suggested to investigate the possibility of controlling the vapor pressure in the equipment in order to better control the growth process.

In all these topics, it is necessary to understand the kinetics at the crystal/melt interface. We will tackle those issues through ongoing collaborative research.

Finally, the Visitor gave an invited talk about Si grain boundary kinetics at the 8th Asian Conference on Crystal Growth and Crystal Technology (CGCT-8, 1st-3rd March 2021). The visitor quality at IMR was publicized in the Author's affiliation.

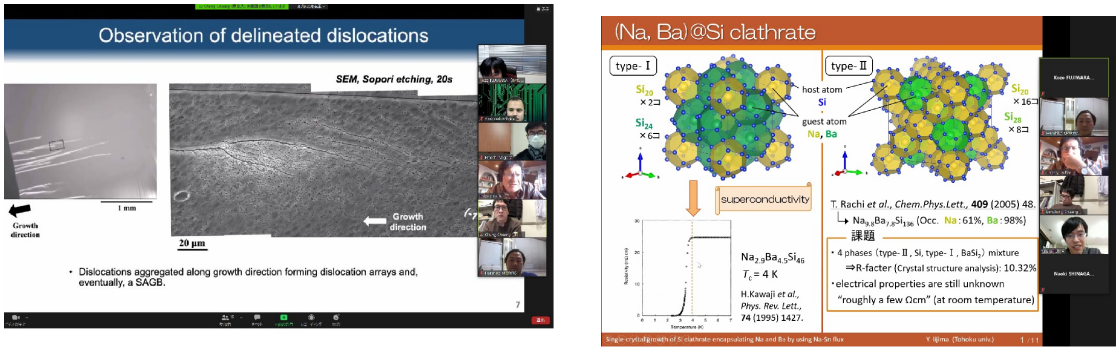

Fig 1. Snap shots of web seminar in Fujiwara's laboratory in IMR.

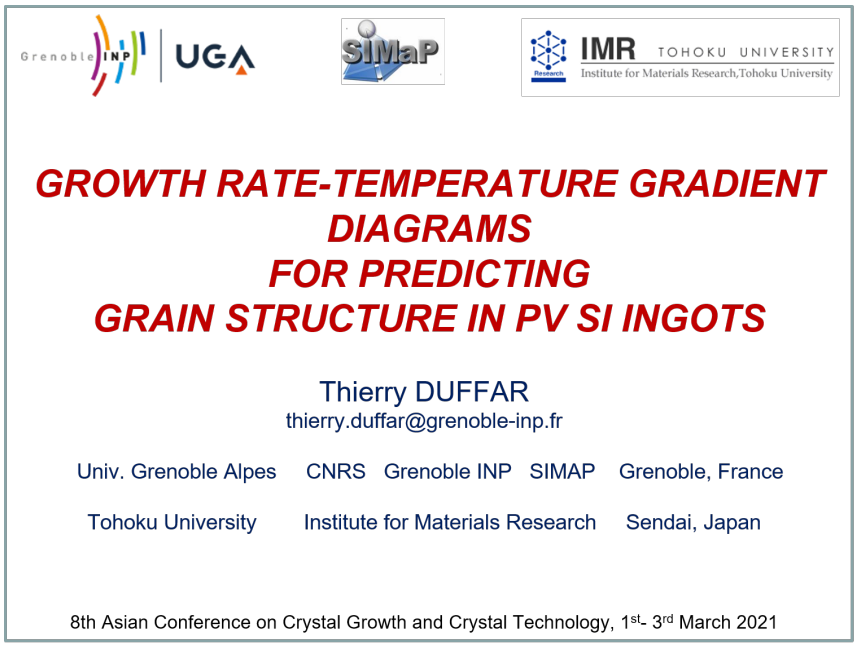

Fig 2. Title slide of Prof. Duffar's linvited lecture at CGCT-8.