

Crystal Growth of Silicon for Solar Cells

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Preface

This book, a continuation of the series “Advances in Materials Research,” is intended to provide the general basis of the science and technology of crystal growth of silicon for solar cells. In the face of the destruction of the global environment, the degradation of world-wide natural resources and the exhaustion of energy sources in the twenty-first century, we all have a sincere desire for a better/safer world in the future.

In these days, we strongly believe that it is important for us to rapidly develop a new environment-friendly clean energy conversion system using solar energy as the ultimate natural energy source. For instance, most of our natural resources and energy sources will be exhausted within the next 100 years. Specifically, the consumption of oil, natural gas, and uranium is a serious problem.

Solar energy is the only ultimate natural energy source. Although 30% of total solar energy is reflected at the earth’s surface, 70% of total solar energy can be available for us to utilize. The available solar energy amounts to several thousand times larger than the world’s energy consumption in 2000 of about 9,000 Mtoe (M ton oil equivalent). To manage 10% of the world’s energy consumption at 2050 by solar energy, we must manufacture 40 GW solar cells per year continuously for 40 years. The required silicon feedstock is about 400,000 ton per year. We believe that this is an attainable target, since it can be realized by increasing the world production of silicon feedstock by 12 times as much as the present production at 2005. To accomplish this target of using solar energy for 10% of the world’s energy consumption at 2050, we must develop several key materials to establish a clean energy cycle, taking into consideration the lifespan of various materials.

Among the various materials, silicon, which accounts for more than 90% of solar cells today, is undoubtedly the key, especially if we consider a large-scale deployment. To accelerate the deployment of photovoltaic technology by development of high-efficiency crystalline silicon solar cells, the Institute for Materials Research (IMR), Tohoku University, organized a unique domestic workshop in 2004 and 2005 to discuss the approach from the view point of

materials science by putting emphasis on crystal growth. Based on the success of the domestic workshop, the first international workshop on “Science and Technology of Crystalline Si Solar Cells (CSSC)” was held at IMR on 2–3 October 2006, coorganized by IMR and Japan Society for the Promotion of Science (JSPS), No. 161 Committee on “Science and Technology of Crystal Growth.” The international workshop has been continued as a forum to provide an opportunity for scientists/engineers from universities, government institutes, and industry to meet and discuss on the latest achievements and challenges in crystalline silicon solar cells from the viewpoint of materials science. CSSC-2 was held in Xiamen, China, on 7–9 December 2007, and CSSC-3 was held in Trondheim, Norway, on 3–5 June 2009. In addition, IMR and JSPS No. 161 Committee organized a special symposium on “Solar Cells and Clean Energy Technology” in the 4th Asian Conference on Crystal Growth and Crystal Growth Technology (CGCT-4), held in Sendai, Japan, on 21–24 May 2008. Most of topics in this book are based on the discussions during these symposia. The editors acknowledge all the participants in CSSC and CGCT-4 for fruitful discussions.

There are several books on the general aspects of solar cells. However, emphasis is mostly placed on the device physics and little attention has been paid for crystal growth technologies. This is partly due to the misunderstanding that there is no room for further improvement of crystals for solar cells. However, this is not true even for multicrystalline Si wafers, whose macroscopic properties could be altered by manipulating their microstructures with the aid of “crystal growth.” The fundamental knowledge obtained through this book is believed to contribute to future developments of novel crystal growth technologies for solar cell materials.

We thank JSPS No. 161 Committee of the “Science and Technology of Crystal Growth” for supporting this book. We also wish to thank Prof. T. Fukuda, the former chairman of the No. 161 committee, Prof. Y. Kawazoe, the Series Editor-in-Chief, for their support and continuous encouragement. We are grateful to Y. Maeda for her formatting assistance. Dr. C. Ascheron and his team from Springer are gratefully acknowledged for the good collaboration.

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