In Situ Observation of Crystal Growth under Zero-Gravity Conditions:
from the Origin of the Solar System to Environment and Energy

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Professor Tsukamoto was born in Osaka Prefecture, Japan in 1948. He got his Masters and Ph.D. degrees in Science from Tohoku University, Japan. For the next few years, he worked in University of Nijmegen, The Netherlands and IBM Zurich Research Laboratory. His research work during this period primarily focused on understanding the crystal growth mechanisms at a fundamental level. After his tenures in these foreign universities, he joined the Graduate School of Science, Tohoku University as a faculty member. Currently, he is also a professor in the Center for Interdisciplinary Research, Tohoku University, Japan.

A crystalline chondrule are contained in meteorites. The earth-borne crystal is surrounded by flat faces, whereas a crystal produced in space is spherical in shape. This example clearly illustrates that the direct way to master the mechanism of crystal growth in space is carrying out experiments in zero-gravity conditions and learning the characteristics of zero-gravity.

In microgravity condition lasting about 20 seconds created by airplane, highly sensitive "on-site" observation instruments can provide enough data relevant to crystal growth. These instruments developed in his laboratory are also being employed in the Japanese Experiment Module (JEM). called Kibo that has recently started its functioning in the International Space Station (ISS).

Looking at phenomena from close quarters is a fundamental need for "on-site" observation of crystal growth processes.

4.6 billion years ago, ultra fine crystals were formed from the gas nebula as the first condensates in the solar system, merged with each other, melted and consolidated to form solar system bodiers. But the crystallization conditions, like the rate of crystallization and the change of environmental temperature are still unknown.

Meteorites contain abundant small spheres called "chondrule" with several millimeters, which provide useful information to exploit the formation of the primitive solar system. However the big question is whether it is valid to extend knowledge acquired on earth to space phenomena. One of the ways to address this question is to have experiences on crystallization under zero-gravity conditions. This was the primary motivation of the group lead by Professor Tsukamoto to carry out space-based experiments by airplane and rockets.

Since the evolutions in crystal growth processes are crucial to elucidate the mechanism from a fundamental view point, varieties of *in-situ* observation techniques were developed in his laboratory. It is capable of determining extremely low growth velocities, 1 micrometer per year in a very short experimental run time.

Results from these *in situ* observations show that instead of several months to tens of thousands of years in space for chondrule crystallization, this process was completed in several seconds (!) time and hence indicates towards rapid crystallization of chondrules.

Facing the global warming, extended his research interests to environment and energy. He has been developing new techniques to convert carbon dioxide in the atmosphere into calcium carbonate crystal and assessing the chronic safety of radioactive waste underground storage.

http://www.ganko.tohoku.ac.jp/shigen/tsukamoto.html