３　Applied Materials

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Applied Materials conducts research and education about the materials design, materials processing and application of special materials which work with characteristic under the various atmosphere to the full.

Professor: Hitoshi Matsumoto

(1) Materials development under extraordinary conditions

Particular attention in this laboratory is called to several methods concerning material processing such as (a)rapid consolidation from molten metal, (b)mechanical alloying under various environmental conditions, (c)high temperature reaction and (d)high pressure shock compression. For a better understanding of each method, it is important that modifying experiments and further enlargement of applicable fields are made on the basis of the evaluation of prepared specimens.

(2) Search and evaluation of a multi functional material

A new material is studied, which show not only the shape memory but also the other property such as high damping capacity, temperature memory, ferromagnetism and high magnetic resistivity.

(3) Characterization of shock phenomena and their application

The shock compaction, shock induced reaction, high pressure transformation and residual effects after a high velocity impact are investigated in order to reveal the shock phenomena and to make a new material.

Professor: Hisao Esaka

1) Development of metallic composite with uniformly-dispersed nano-particles

Composite materials will be directly produced via solidification. In this research project, condition of solidification (solute content, temperature gradient and growth velocity) will be analyzed for production of metallic composite.

This photograph shows the cross section of unidirectionally-solidified Sn-Cu eutectic alloy. Various fine rods of eutectic Cu_6Sn_5 were uniformly dispersed and aligned in the eutectic Sn matrix. Using such a eutectic alloy, we would like to produce uniform and isotropic material.

2) In-situ observation of solidification process using a laser microscope

A special hot stage is also installed in the laser microscope. Using this experimental equipment, solidification process of metallic system will be directly observed.

These photographs are the example of in-situ observation of solidification of Sn-Ag alloy.

a) Completely liquid phase

b) Some small protrusions emerged in the specimen. These were the tips of primary Sn dendrite (arrows).

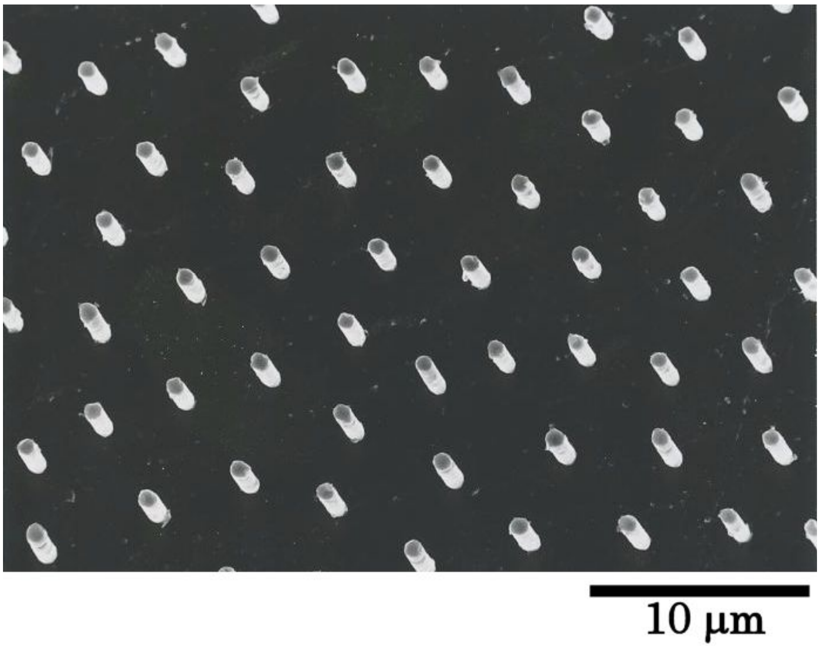
c) After some seconds, eutectic solidification started as an arrow indicated.

d) Completely solidified

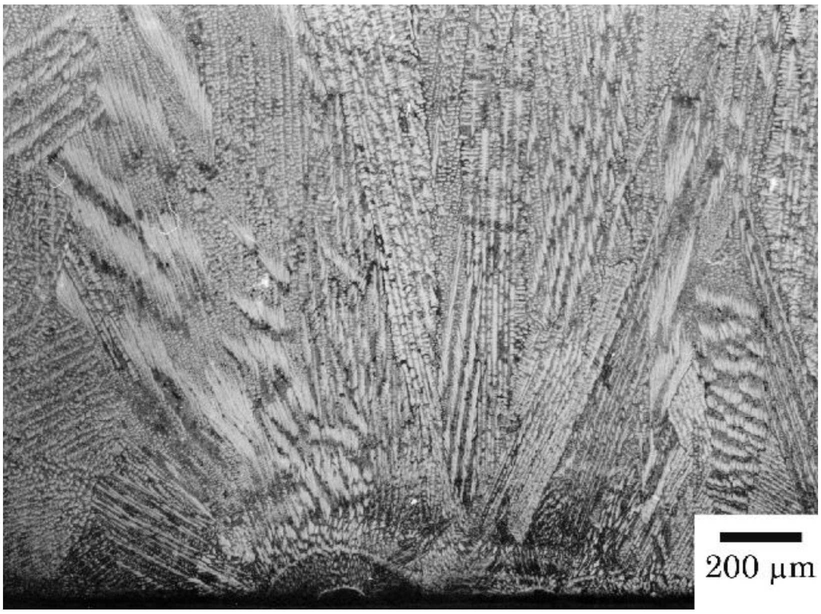
On can understand how solid phase grows and how solidification proceeds owing to this kind of in-situ observation. We will analyze the evolution of solidified structure as functions of cooling rate, solute content etc.

3) Control of solidified structure taking nucleation on the chill plate into consideration

Starting point of solidification (=liquid to solid transformation) is nucleation. Thus a nucleation phenomenon is quite important to understand the evolution of solidified structure.



Photograph 1 shows the "disc" found on the surface of solidified shell of high carbon steel. Thanks to the newly developed experimental technique, we could observe the very surface of the shell without oxidation and find discs, which were the trace of nucleation on the surface.



Photograph 2 shows the racially grown dendrites from a nucleus found in Sn alloy. When the number of nuclei on the surface is large, one can obtain fine structure. On the other hand, if there is only one nucleus, one obtain a single crystal. Thus, control of nucleation on the surface is of importance.

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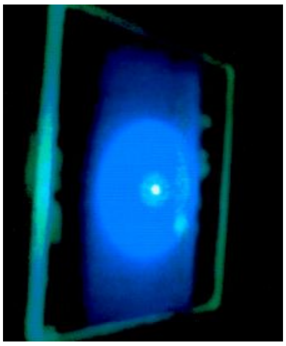
Associate Professor; *Dr.(Engineering), 1995 Tokyo Institute of Technology:* Optical properties of inorganic and organic-inorganic materials; Low-dimensional materials; Sol-gel derived materials

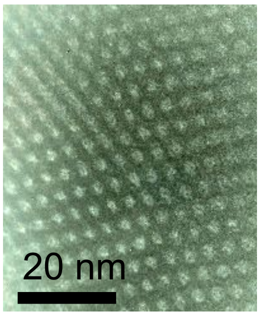
Research in our group focuses on the synthesis of nano-materials and characterization of their optical and electrical properties. One of the principal themes which extends to each of the research activities is the use of self-assembly process to create nano-materials with ordered structures. The research areas are described below.

Synthesis and Optical Properties of Low-dimensional Materials



Low-dimensional materials with quantum functions have attracted considerable interest due to the possibility of creating interesting optoelectronic devices. One of our research directions is to use self-assembly process to create unique materials with natural quantum-well (two-dimensional layered) structures. In our current research involves the synthesis and characterization of lead-halide based perovskite compounds. Thin films of these compounds showed pronounced exciton emission even at room temperature (see picture).

Nano-structured Materials through Self-Assembly



Another project in our group involves a study of sol-gel derived materials with unique nanostructure and properties. In our recent work we add surfactants (block copolymers) to sols, leading to the formation of mesostructured oxide films via evaporation-induced self-assembly. Recently, mesoporous silica films have been prepared by modifying the sol-gel method in the presence of amphiphilic triblock copolymers as a structure-directing agent (see picture). With this process we are also able to fabricate mesoporous titania films with an ordered nanostructure.