

PD Interview

Program Director Interview

12 Leading Experts Who Accelerate SIP



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Revolutionary Structural Materials Development by Data-Driven System in MI System

Leading the world by passing on Japan's advantages in the materials industry to a new material development system

Expectations for new structural materials are increasing in various fields including transportation equipment (aircraft parts, etc.) and the environment and energy. However, it has been common for the conventional development method to take 10 to 20 years because multiple properties and long-term durability are required for advanced structural materials. We interviewed Program Director (PD) Professor MISHIMA Yoshinao, who is promoting the development and social implementation of the "MI system," which has the potential to reduce the development period to several years.

Reduction of development period and cost by new structural materials design method

Q: Manufacturing is undergoing a major transformation in Western countries, China, and other foreign countries. Could you tell us Japan's strengths and efforts related to SIP?

PD: First of all, as a premise, there are roughly two types of materials: functional and structural materials. Development of functional materials can be realized for practical use by searching for substances having the functions and physical properties that the materials should have, such as permanent magnets and thermoelectric conversion element materials, and then realizing mass production and cost reduction.

On the other hand, structural materials are used for the bodies and engine components of aircraft and automobiles, and the frameworks of bridges and buildings, and they are required to have mechanical strength and various properties. For example, heat-resistant materials used for thermal power generation require not only strength at room temperature but also high-temperature strength at 600 to 800 degrees Celsius. Furthermore, corrosion and fatigue resistance are also required. Therefore, structural materials require very complex designs and have been said to take 10 to 20 years to develop. We are aiming to shorten the development period and reduce the R&D costs by trying to develop the difficult design process with the Materials Integration (MI) system.

Japanese manufacturing is also said to be the world leader in structural materials. It is well known that there is no variation in the manufacturing process in which equally high-quality

products are produced even by different material manufacturers only by being under the same standards. However, global manufacturing is entering an era of major change where Western countries and China intensively invest. In the SIP project, we believe that our technological superiority in the materials field can be maintained by leveraging Japan's strength to date and offering good materials faster to the world.

Development of multiple new materials using the MI System

Q: What is the MI system?

PD: We have been working on an approach to realize the required manufacturing process starting from the desired material properties by reversely tracing the process to analyze the past data with materials and information engineering for the flow to obtain specific properties in the materials manufacturing process. This is also called inverse design.

That is, we aim to realize a manufacturing process to provide required performance and material properties when we think "We want to make a material like this," by referring to the MI system database that accumulates material properties and processing data, and performing information analysis that combines various technologies and methods including AI. By utilizing the MI system, we can now propose a method for the development and design of structural materials in just a few years, and expect significant reduction in cost and development period, which used to take many years.

Structural materials such as steel, aluminum alloy, and nickel



alloy that Japan has supplied domestically and internationally maintain world-class quality and reliability, and this development record and data are a great advantage. Taking advantage of these strengths, in addition to these metal and alloy materials, we have also started to develop structural materials such as carbon fiber reinforced plastic (CFRP), and are conducting research to demonstrate that the MI system is effective in developing practical materials.

Build a consortium to cover broader requirements such as security

Q: I heard that you will proceed with building a consortium for the social implementation of the MI system. What kind of a regime are you aiming for?

PD: It is meaningless even if building a foundation for the MI system and creating successful examples unless it is used. Therefore, we are thinking of getting new talents from various fields such as small and medium-sized enterprises, ventures, medical science, social science, and humanities science in addition to the organizations that have launched a consortium and cooperated with SIP. So far, as a part of our MI system project, we have hosted online information sessions and seminars, in which more people have participated than expected. One of the things we would like to achieve in the 2nd period of SIP is to make where different fields in Japan collaborate in the future to create new materials that will change society.

Q: You said that you need to cover broader requirements such as security in addition to material technology development. What kind of initiatives are you taking?

PD: Information security is very important so that people can use the system with peace of mind. In order to protect intellectual property, in addition to formulating rules and contracts in detail to be observed when participating in the consortium, we will consider appropriately designing the scope of data that can be used within the consortium and the route of use.

On the other hand, ideally, open innovation, where companies jointly exchange data with each other in order to efficiently bring out innovative products/technologies in a shorter period of time in fields where a very large market for new structural materials is assumed, is expected. I would love to have non-SIP participating organizations, without sticking to all-by-ourselves-ism, in the consortium to make the best use of the MI system to aim for manufacturing that transcends the boundaries of industry.

Succeeded in developing a resin for multifunctional CFRP and additive manufacturing of nickel-based alloy

Q: I’ve heard that research on multifunctional CFRP is achieving remarkable results.

PD: The aim of developing high functional fiber-reinforced composite materials as well as metal/alloy-based structural materials is an important point in this SIP. Especially, the development of flame-retardant CFRP resin is a major achievement. Using the Self-Organizing Map to be installed in the MI system, we clarified the target area that has both conflicting properties such as flame retardancy and heat resistance.

Aluminum alloy has traditionally been used in aircraft structures, but the need for lighter CFRP is growing rapidly and will continue to grow. Since this is a field where Japan has world-class technologies, we are anticipating opportunities in broader markets such as transportation equipment like electric vehicles not just aircraft through development and manufacturing of even more sophisticated CFRP.

Q: Domain C “3D Powder Processing” is also seeing great results.

PD: The combustion burner of a gas turbine is being produced by a new manufacturing method called Additive Manufacturing. This is the method to build a complex 3D structure by laying down one layer of nickel-based heat-resistant alloy powder, moving the laser to trace the cross-section view of the part, melting and solidifying only necessary portions by moving the laser to trace the cross-section view of the part, and repeating the operation in order. Burners that use hydrogen fuel have a complicated structure because it is difficult to mix them with air, control the temperature and flow rate, and withstand high temperatures. The best achievement of developing this was to realize the process conditions to prevent cracking.

Q: Could you share with us what kind of efforts you are going to make in order to realize this program?

PD: There has been no precedent development case of a mechanism like the MI system in the development of structural materials so far. Our goal for this fiscal year is to acquire a highly accurate international benchmark, secure our international position, and build an attractive system. In addition, we will work to consolidate the consortium to make the system easier for more people to use by the 2nd period of SIP.