Establishment of CAMECA-NIMS 3DAP Laboratory

26th June, 2018
National Institute for Materials Science
CAMECA Business Unit, AMETEK Co., Ltd.

Overview

1. On June 26, the National Institute for Materials Science and CAMECA Business Unit, AMETEK Co., Ltd., established the CAMECA-NIMS 3DAP Laboratory for educational and awareness activities for 3D atom probe (3DAP) technology, which can three-dimensionally visualize the distribution of the atoms that make up a material. CAMECA will install a state-of-the-art 3D atom probe at NIMS, make it available to external users through a user consortium, and provide technical instruction on utilizing the 3D atom probe as a standard method for material analysis at businesses or universities.

2. The 3D atom probe method can detect and identify the position of single atoms including light elements, which are difficult to observe with electron microscopes. It is also very effective in analyzing the distribution of elements within a variety of materials or devices. NIMS has played a leading role in this area; for example, it has developed an original laser atom probe and was the first in the world to succeed in atom probe analysis of bulk insulators, significantly extending the range of its application. CAMECA is contributing to the development and global popularization of this method as the world's only manufacturer of commercial 3D atom probe devices. However, the popularity of this method is still limited due to the special characteristics of its devices (e.g. sample preparation, measurement methods, analysis method expertise).

3. This is why CAMECA-NIMS 3DAP Laboratory will install CAMECA's latest 3D atom probe model (EIKOS-X) at NIMS, in addition to a state-of-the-art atom probe (LEAP-5000 XS) owned by NIMS, and make it available to external users. The device will be available for use free of charge for joint studies with NIMS whose results will be released, and in exchange for a cooperation fee for studies conducted by businesses whose results will not be released. There will be regular lectures on 3D atom probe technology, as well as dedicated operators to provide technical instruction and support for sample preparation and analysis. At this time, devices owned by NIMS (FIB/SEM) can also be used for a fee.

4. The CAMECA-NIMS 3DAP Laboratory will considerably lower the barrier to the use of atom probes in material development, raising expectations for a variety of applications and making a significant contribution to the academic and industrial worlds.

The National Institute for Materials Science (located in Tsukuba City, Ibaraki Prefecture; President: Kazuhito Hashimoto; hereafter, “NIMS”) and CAMECA Business Unit of AMETEK Co., Ltd. (Headquarters: Minato Ward, Tokyo; President: Tetsushi Kuse; hereafter, “CAMECA”) established CAMECA-NIMS 3DAP Laboratory for educational and awareness activities for 3D atom probe technology[*1], which can analyze the distribution of elements forming a material as 3D tomography at single-atom resolution.

NIMS has played a leading role in this area; for example, it has developed an original laser atom probe and was the first in the world to succeed in atom probe analysis of bulk insulators using an ultraviolet laser. CAMECA is contributing to the development and global popularization of this method as the only manufacturer of commercial 3D atom probe devices at present. To date, this device has been installed in 71 research institutes and universities around the world and is used to analyze a variety of materials, 99% of which have been sold by CAMECA, marking exclusive results. There are nine research institutes and businesses using this device in Japan.

The 3D atom probe method is the only method to visualize the distribution of atoms as 3D tomography at a magnification ratio of over 1 million by simultaneously measuring the mass and position of atoms ionized with lasers from the tip of a needle-shaped sample (Figure 1). For example, this method can precisely analyze the distribution of elements within a nanoscale device or the uneven distribution of nanoscale elements within a material. While even the latest transmission electron microscope (TEM) has difficulty in quantitatively analyzing light elements segregating to a defect, the 3D atom probe makes it possible to directly observe elements segregating to a defect on the atomic plane or a one-dimensional defect within a crystal called dislocation (Figure 2). However, the atom probe has not become very popular among science and engineering faculties at Japanese universities because it requires special expertise and its devices are expensive. There have been serious barriers to the introduction and use of those devices at universities and businesses because there are extremely limited opportunities to learn sample preparation, measurement methods, and analysis method expertise.

In FY2017, NIMS introduced CAMECA’s state-of-the-art commercial atom probe (LEAP-5000 XS), which can perform ionization with ultraviolet radiation lasers. Also, the 3D atom probe (EIKOS-X), which was developed as a popular model by CAMECA, will be installed at NIMS, and a joint lab will be established with NIMS to make it available to external users. This EIKOS-X will be launched at the same time as the Lab, and it will be offered through the EIKOS Consortium (Representative: Songsu Cho, CAMECA Business Unit Manager, AMETEK Co., Ltd.) in exchange for a cooperation fee depending on the occupancy of the device, even if the study’s analysis results will not be released. The device is also available free of charge for joint studies with NIMS whose results will be released.

CAMECA-NIMS 3DAP Laboratory will provide regular lectures on the 3D atom probe method and technical instruction by dedicated operators for sample preparation, measurement and analysis. When samples must be prepared at the Lab, the FIB/SEM device (FEI Helios G4) of NIMS can be used for a fee or free of charge depending on whether the study results will be released. This allows even researchers at businesses or educational/research institutes who have not used a 3D atom probe to use the 3D atom probe analysis method for material study.

(*1) 3D atom probe technology: A mass spectrograph that identifies atom position and processes an analyzed sample into the shape of a needle with a tip radius curvature of around 50 nm. It applies a laser pulse onto the sample under high voltage to ionize the atoms from the sample’s surface while simultaneously measuring the mass and position of those ions. Because ionization is detected when it is projected from the needle onto the surface of the detector, the magnification ratio of the projection exceeds 1 million, so the atom position

can be identified at a sub-nanometer position resolution. By conducting this continuously, this method three-dimensionally analyzes the position and type of atoms evaporating sequentially from the surface of the sample.

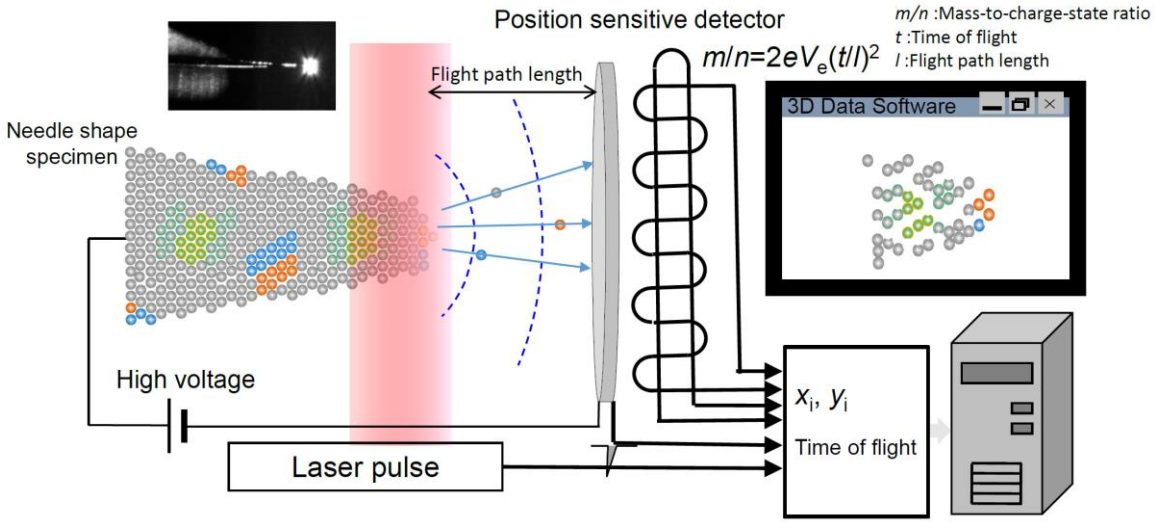

Fig.1 Principle of laser assisted 3D atom probe

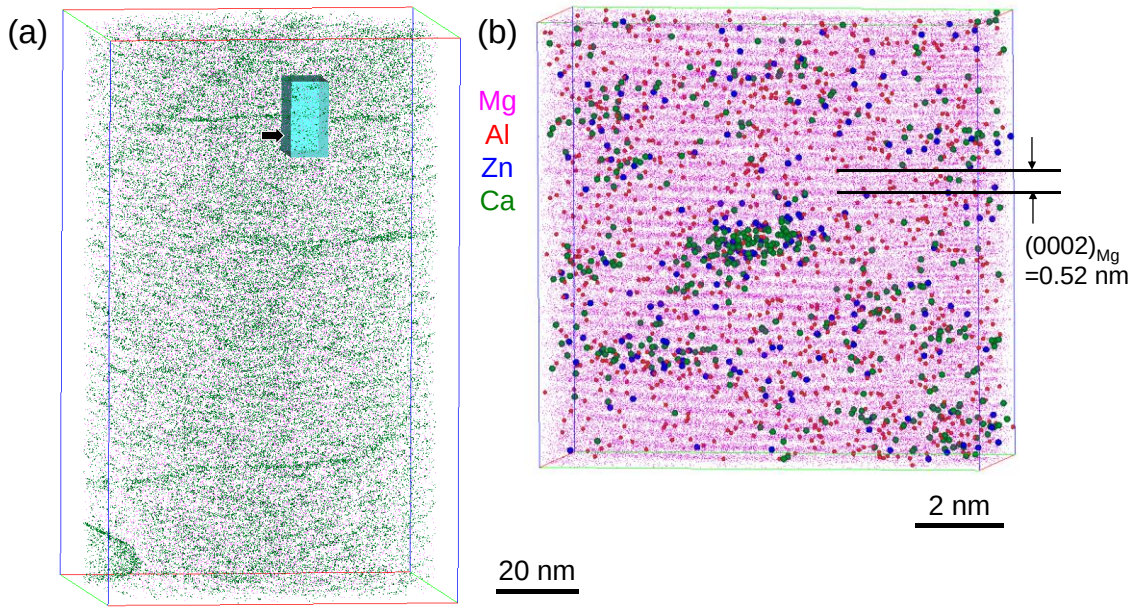

Fig. 2 Example of atom probe analysis. (a) 3D atom map showing solute segregation of alloying elements (Ca and Zn) along dislocation cores in a magnesium based alloy. (b) Magnified 3D atom map obtained from the selected volume indicated by light blue in (a). Segregation of Ca and Zn along the dislocation core is clearly visible.

Devices at CAMECA-NIMS 3DAP Laboratory

- Laser atom probe: CAMECA EIKOS-X

Pulse	Voltage/laser
Laser wavelength	Visible light
Detection efficiency	Up to 37%
Applicable sample	Metallic materials

EIKOS-X

- Laser atom probe: CAMECA LEAP 5000 XS

Pulse	Voltage/laser
Laser wavelength	Ultraviolet radiation
Detection efficiency	Up to 80%
Applicable sample	Metallic materials, semiconductors, ceramics

LEAP 5000 XS

- FIB/SEM: FEI Helios G4

FIB acceleration voltage	500V - 30kV
SEM resolution	0.7nm @ 1kV
Detector	Inlens SE/BSE Everhart-Thornley SE, ICE, STEM
Film formation mechanism	Platinum

Helios G4

Contacts

(Regarding this project)
National Institute for Materials Science
CAMECA-NIMS 3DAP Laboratory Manager
Tadakatsu Ohkubo
TEL: +81-29-859-2716
E-mail: ohkubo.tadakatsu@nims.go.jp

AMETEK Co. Ltd CAMECA BU
BU Manager Songsu Cho
Shiba NBF tower 3f, 1-1-30,
Shiba-Daimon, Minato-ku, Tokyo
TEL：+81-3-4400-2330
E-mail: Songsu.Cho@ametek.com

(For general inquiries)
Public Relations Office
National Institute for Materials Science
TEL: +81-29-859-2026, FAX: +81-29-859-2017
E-mail: pressrelease@ml.nims.go.jp