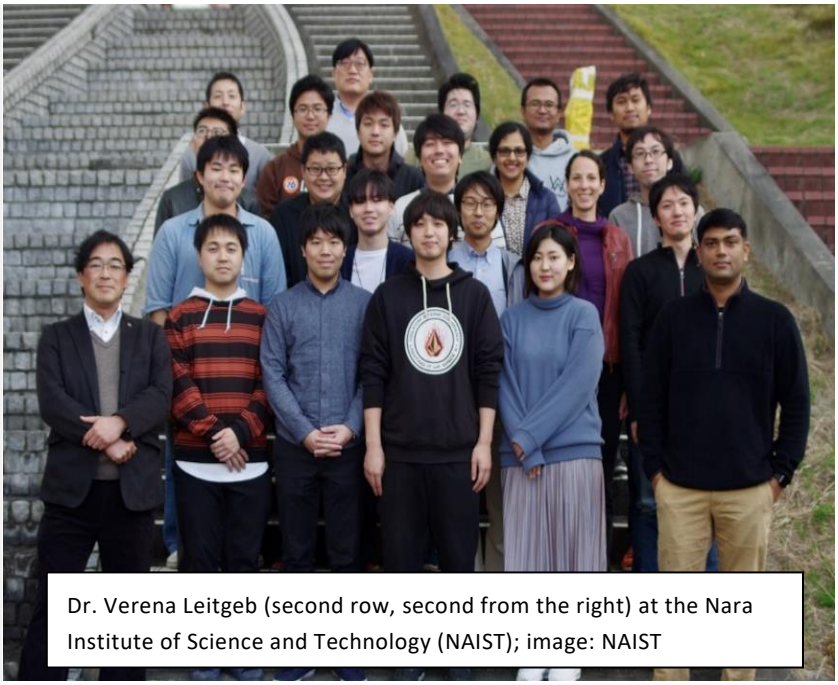
SUCCESS STORY

IC-MPPE / Integrated Computational Materials Process and Product Engineering

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Centre (K2)

Project P1.1: "Fundamentals and tools for integrated computational modelling and experimental characterization of materials in the atomic to micro meter scale range" Strategic project (2018-2022)



Dr. Verena Leitgeb (second row, second from the right) at the Nara Institute of Science and Technology (NAIST); image: NAIST

IC-MPPE COLLABORATION WITH THE NARA INSTITUTE OF SCIENCE AND TECHNOLOGY IN JAPAN

RESEARCH STAY AT THE NARA INSTITUTE OF SCIENCE AND TECHNOLOGY FOR HIGH RESOLUTION THERMAL INVESTIGATIONS FOR THERMOELECTRIC MATERIALS

Within the IC-MPPE programme, selected scientists get the possibility to broaden their horizon by an extended research stay at a university or company abroad. Dr. Verena Leitgeb (MCL) visited the Department of Materials Science at the Nara Institute of Science and Technology (NAIST) in Japan for 4 months in 2019.

Goal of her research stay was to exchange knowledge on high-resolution thermal characterisation techniques and work together with the group of Prof. Nakamura on the development of novel and flexible thermoelectric materials. NAIST is aiming to improve the thermoelectric properties of systems based on so-called carbon nanotubes (tiny tube-like structures made of carbon) for the use in small power generators or wearable electronics. Dr. Leitgeb used her experience in the field of scanning probe microscopy to set up the new FM-AFMP (Frequency Modulation Atomic Force Microscope/ Potentiometer) at NAIST.

This special microscope makes it possible to measure thermal properties on organic materials down to the molecular scale. By FM-AFMP characterization, the heat transfer over junctions between carbon nanotubes and special protein molecules can be studied in detail. These molecules consist of a

semiconductor core that is electrically conducting, and a soft shell of low thermal conductivity, which prevents heat transfer from one carbon nanotube to another. By modifying the nanotubes with such proteins, materials can be designed which have excellent thermal and electric properties, for, e.g., thermoelectric fabrics implementable in everyday clothes.

Impact and effects

During her research stay, Dr. Leitgeb recorded first images of proteins attached to carbon nanotubes with the FM-AFMP, which brought the group of Prof. Nakamura a big step closer to understand the thermal transport in carbon nanotubes-protein systems. Further studies on nanotubes applied on an AFM sample holder with temperature gradient are currently work in progress; the results will be presented in a common MCL-NAIST publication.

"Working together with the NAIST team enabled me on the one hand to gain a deeper understanding of innovative materials in nanoelectronics, on the other hand I was able to improve my know-how in the area of optimizing the measurement parameters for taking high-resolution images. "This knowledge will also be very valuable to promote AFM techniques at MCL, like our Scanning Thermal Microscope (SThM)", explains Dr. Leitgeb.

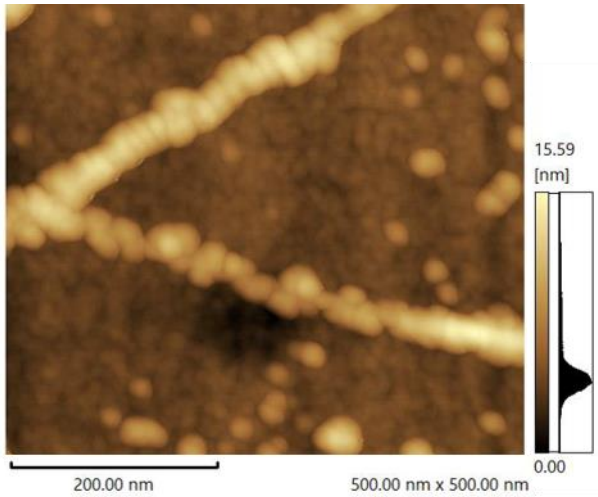


Image showing bundle of carbon nanotubes with proteins attached, each bundle being about 5.000 times thinner than a single human hair. Recorded at Laboratory for Organic Electronics at NAIST.

Further collaborations between MCL and NAIST are planned. One hot topic is to study thermal interface resistance between organic and inorganic materials with the TDTR (Time Domain Thermal Reflectance), an optical method to study thermal properties of thin films. The knowledge gained in such studies can be applied to promote the development of flexible thin films with tailored electric and thermal properties, an important part of modern electronic systems.

Project coordination (Story)
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Project partner

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