

## MERIT-WINGS Long-term overseas dispatch

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Staying time: 2024/9/15 - 2024/12/15

Research theme: Stretchable photodiode fabrication for wearable healthcare devices

### ■ Research Background

Twenty-four-hour monitoring of bio signal helps early detection of health condition change. For this purpose, the healthcare devices should be enough comfortable to be worn all day long. Softness and skin conformability are important factors for next generation wearable healthcare monitoring.

Photodiodes are one of the important components in healthcare monitoring devices, as it can be used to measure heart rate or  $\text{SpO}_2$  by converting light intensity change into electric signal. For accurate measurement, photodiodes should be closely attached to the skin, to prevent the ambient light to shine in.

VTT Technical Research Centre of Finland is a research institute that works on industry application and commercializing of science and technology. They have excellent experience and facility for prototyping wearable devices in roll-to-roll process, which is very close to real factorial manufacturing. The large roll-to-roll pilot line allows us to test the condition for mass production.

### ■ Research contents and results achieved during this stay

We have already examined how to fabricate a highly stretchable photodiode in Japan before the visit to Finland. In this stay, the stretchable photodiode fabrication process has been changed with 2 steps.

The first step was to substitute Eutectic Gallium Indium (EGaIn) with PEDOT:PSS and PEIE. EGaIn was used as the stretchable electrode because it shows high conductivity and high stretchability at the same time. However, its liquidity and metal corrosive characteristics may give a big damage on other metallic devices when it accidentally leaked.

The second step was that each operation in the photodiode production process has been changed to one that can be used in a roll-to-roll process. In the previous photodiode, several

layers were fabricated with spin-coating, but spin-coat cannot be used in the roll-to-roll process, therefore spin-coating has been replaced with inkjet printing, slot die coating, or screen printing.

## ■ Life in Finland

The researchers in VTT were all very responsible, for example on maintaining the machines or when they face some problems. They seemed to have more leeway on time than people in my laboratory, so that they could spend several hours for teaching me how to use the equipment. They also gave a lot of importance on communication, so there was coffee time every day.

Finnish language was used as much as we use Japanese in Japan. Foods sold in supermarkets mostly had only Finnish & Swedish instruction. The notice in the laboratory was also mostly written only in Finnish at first, but my colleagues added English translation for me during my stay. However, when communicating with people, I did not face any problem with English.

The winter in Oulu was colder than that in Tokyo. The open air was cold from September, but the indoor temperature was 20°C at most of the places. However, people in Finland were more worried about the darkness than the coldness. The meridian altitude is dropping day by day before the winter solstice and cloudy skies hid the few rays of sunshine. Everyone says that if snow covers everything, the reflections make it brighter and everything better, but this year we did not have much snow before Christmas, so, it was just dark.

There were some Japanese restaurants in Oulu, such as ramen, katsu-curry. I saw sushi at almost every supermarket.

Finnish people watch *Tunttematon sotilas* (The Unknown Soldier) in the day and the program in which Finnish president shakes hands with Finnish celebrities at night, on the Independence Day.

## ■ Acknowledgments

I would like to show my gratitude to Dr. Mohammad Behfar, Prof. Naoji Matsuhisa, Dr. Teemu Alajoki, and every colleague in VTT. This stay was financially supported by MERIT-WINGS and JST ASPIRE JPMJAP2336.