Next generation healthcare, Agriculture IoT, Construction tech

Co-creation of advanced materials and sensor systems toward regional smart cities

Department of Advanced Materials and Implementations, SANKEN (The Institute of Scientific and Industrial Research)

Associate Professor Teppei Araki Researchmap https://researchmap.jp/teppei_araki?lang=en

Specially Appointed Assistant Professor Takaaki Abe Researchmap https://researchmap.jp/taka_abe?lang=en

Abstract

With the aim of contributing to the creation of sustainable smart city where local residents can live safely and securely by solving issues hidden in local communities, we are conducting basic research on advanced materials and electronic devices, as well as applied research to create a “sensor system for caring objects that act as usual” using IoT and other technologies. The sensor system functions as a “trusted interface between people and digital” and realizes healthcare for people, facilities, and nature that support the community. When promoting research, we are also trying to collaborate with all stakeholders to implement technology in regional smart cities and co-create new value from scratch.

Background & Results

In recent years, more than 4 million people in Japan have been suffered from stress-related diseases. Meanwhile, a demand for wearable sensor technology has been increased to quantify stress in daily life. Here, we have developed a thin-film, stretched, and transparent probe that can wirelessly measure low-noise potential signals (about 0.1 μV) equivalent to medical materials by utilizing biocompatible nanomaterials. The biocompatible probe, which are one of the key components, are fabricated with elastomers and conductive polymers and forms a phase separation structure in the size of nano to micrometer to exhibit that various performances. In addition, we developed highly conductive and transparent conductors using an metallic material consisting of Ag/Au core-shell nanowires, which are invisible to the naked eye as the wiring material. Transparent sensor sheets made of biocompatible probe and conductors exhibit high charge mobility and achieve low-noise potential measurements equivalent to those of medical materials, resulting in a multimodal detection for stress markers such as electroencephalogram, electrocardiogram, myograph, pulse wave, blood flow, and blood oxygen saturation.

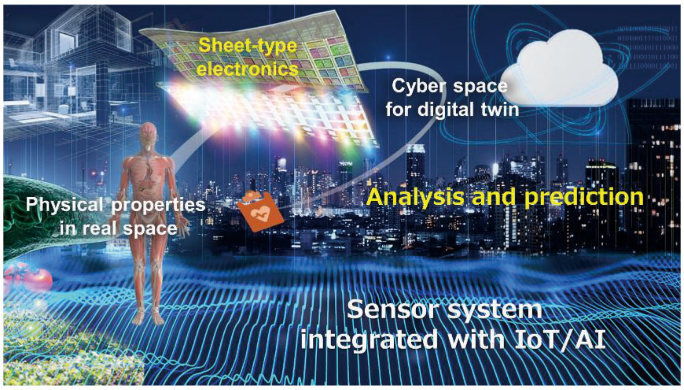
New techniques for precisely layering and patterning the above-mentioned conductor and semiconductor nanomaterials have been developed for a thin-film, flexible, and transparent transistor. The transistors can amplify the potential signal obtained from the probe to achieve high-quality probing with an improved signal-to-noise ratio.

A thin and soft sheet-type optical sensor using transistors have been developed to detect broadband light (visible light to terahertz) with wavelengths that differ by more than three orders of magnitude with high sensitivity. As a result, the possibility of non-invasive monitoring of multiple functions such as biological metabolites, body temperature, and pulse waves has expanded for stress detection.

Sheet-type sensors, which can measure minute signals of light and electricity with high quality, are as flexible as human skin, expanding their feasibility as multimodal wearable sensors (e-skins) that can be worn for a long time. It is becoming possible to construct a compact, lightweight, and user-friendly inspection system not only for living tissues but also for infrastructure structures and natural structures.

Significance of the research and Future perspective

Sheet-type sensors, which serve as translators between real and digital spaces, are highly flexible and transparent, so they can extract internal features without burdening the object even when they are attached to surfaces of objects such as people, facilities, and nature. In the future, the high-quality data of “objects that act as usual” obtained by sheet-type sensors will be stored in the cloud to build digital twins, predict abnormalities in people, crops, infrastructure structures, etc., and build efficient systems for rapid response.



Patent Japanese Patent No. 6889941, No. 6865427, No. 6832535

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