

Realization of a next-generation agriculture sensor platform using IoT technology

— microscale xylem sap flow sensor using MEMS technology —

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Propose of research

Recently, the demand for stable and sustainable crop production has increased because of environmental problems or decline in agricultural population. In plant factories and the farming industry, the realization of a next-generation agriculture sensor platform using IoT technology is expected. However, it is mostly limited to monitoring environmental information such as temperature, humidity, solar radiation, and CO₂ concentration. The realization of moisture control and fertilizer management based on the biological information of plants makes it possible to maintain suitable sap dynamics for crop and fruit production.

Summary of research results

Figure 1 shows a comparison of the configurations of proposed microscale xylem sap flow sensor with Granier sensor, which is a conventional xylem sap flow sensing method. The measurement range of the Granier sensor is the plant stem diameter of 10 cm or more. Therefore, the flow velocity at the end of the plant stem (plant shoot) could not be directly measured. To solve this problem, we propose a microscale xylem sap flow sensor that uses the measuring principle of the Granier method by applying MEMS technology. As shown in Figure 1, our sensor is reduced to 1/10 the size of a conventional Granier sensor, and the sap flow amount of a small-diameter plant can be measured with low damage.

In this study, we fabricated a prototype micro-sensor integrating micro-heater, temperature sensor and microneedles on a si chip by using MEMS technology, and assembled them on a resin film to facilitate mounting on the epidermis of plants. Furthermore, we measured the sap dynamics by using an experimental setup with a mimicked plant, and succeeded in measuring the flow velocity (several tens or a few hundred $\mu\text{m/s}$) and diurnal variation in actual plant (*Cucumis sativus L.* and *Solanum Lycopersicum L.*, etc.).

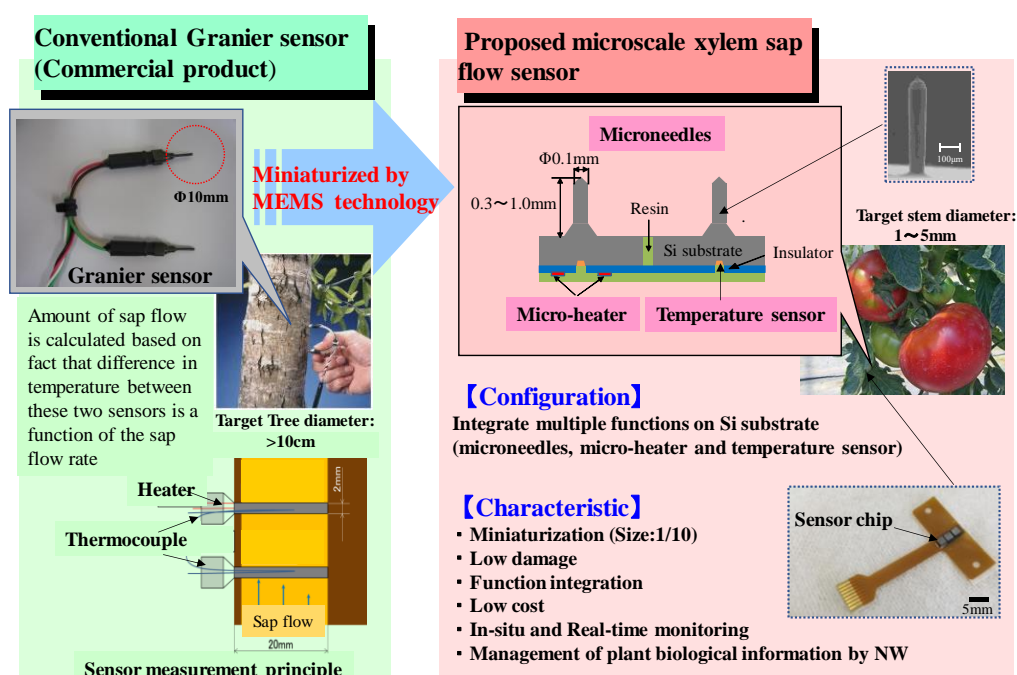


Figure 1 Comparison of configurations of proposed microscale xylem sap flow sensor with conventional Granier sensor (Commercial product)