HEALTH-CARE APPLICATIONS FIRST

BIOSENSORS GALORE

TOKYO—By the end of the decade, the confluence of biotechnology and microelectronics will produce a host of cheap, disposable biosensors. Such is the word from Japan, where biosensor research is marching steadfastly into the future.

"In Japan," notes Isao Karube of Tokyo University's Research Center for Advanced Science and Technology (RCAST), "the main application field will be health care, for which companies like INAX and Toto are developing disposable biosensors." Initially, says Karube, commercial biosensors will be used in medical diagnosis and treatment. Subsequent biosensor applications will be found in food production and environmental monitoring. "Furthermore, telemetric biosensors for monitoring fatigue could be of interest in sports and athletics," Karube adds. "In the home, sensors for odor, freshness, and taste of foods could be used to determine food quality."

Biosensors should prove lucrative as well as ubiquitous. According to Japan's Economic Planning Agency (EPA), the domestic market for biosensors will reach ¥2 trillion, or $16 billion, by the year 2000. The market will be dominated by the disposable devices mentioned above.

Karube, one of Japan's leading figures in biosensor research, is renowned for the development of the Ion-Sensitive Field Effect Transistor (ISFET), a micro-pH device made with the technology used to fabricate silicon devices. Karube states that ISFETs are useful for the potentiometric function of microbiosensors because of their sensitivity to ion concentration and charge.

Karube and his co-workers at RCAST have fabricated a variety of ISFET-based microbiosensors, including:

- a urea microsensor using polyvinylbutyral (PVB) as a membrane material (PVB membranes exhibit good adhesion to the sensor's silicon nitride surface, thinness, porosity, and are hydrophilic);
- a bioelectrochemical system for adenosine triphosphate determination;
- an alcohol-sensitive ISFET which responds to ethanol and propan-1-ol.

Karube and colleagues have also developed a-ISFET microbiosensors (using amorphous silicon) which determine the rate hypoxathine generated as ATP (adenosine-5'diphosphate) decomposes into AMP (adenosine-5'-monophosphate). In the near future, these so-called "fish-freshness" sensors are expected to be incorporated into commercial food packaging, where they will change color to alert consumers when a food product is no longer fresh.

In Japan, close cooperation between industry, academia, and government is the norm—and the area of biosensor development is no exception. Quite a few Japanese firms are in the biosensor business, a number of which are working with Karube and others at Tokyo University. For example, Karube has worked with Nippon Denso to develop a "fatigue-monitoring" biosensor that is intended to keep tabs on a driver's state of alertness. And with INAX researchers, Karube is developing a "toilet sensor" to monitor various bodily functions in the home.

Some of these efforts have already proved fruitful. Several firms are now selling glucose, fructose, BOD (biochemical oxygen demand), lactic acid, and hydrogen peroxide biosensors. Of these, the most prevalent is the glucose sensor. **—Stuart M. Dambrot**

COMPANY	BIOSENSOR R&D ACTIVITY
Dainippon Printing	immune-system monitoring
INAX	*in vitro* measurement of albumen in urine
Itoh	high-sensitivity meat freshness
Nichirei	optical measurement of fish freshness
Nippon Denso	measurement of lactic acid and ammonia in perspiration to determine fatigue
Nissin Seifun	fruit ripeness
Seiko Denshi	artificial pancreas combining biosensor and micromachining
Takenak Kohmuten	environmental pollution monitoring
Toto	health and medical monitoring

Source: Weekly Diamond