Ion-Selective Field Effect Transistors for pH Sensing

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When examining the properties of a solution, pH is one of the most important chemical parameters to be aware of. The term was first introduced by Soren Peter Lauritz Sorensen (1868-1939), a Danish biochemist, and is used to denote the acidity or the alkalinity of an aqueous solution [1]. In chemistry, the pH values of a solution are denoted on a scale, usually from 0 to 14. When a solution has a pH of 7 at 25°C, then the solution is called "neutral". When a solution increasingly approaches pH 1, it becomes more acidic, while when it approaches pH 14 it becomes more basic. This simple way of measuring the acidic and basic properties is incredibly important across many industries as well as ecosystems and organisms since the value of pH can quickly give an insight into the conditions of an aqueous solution.

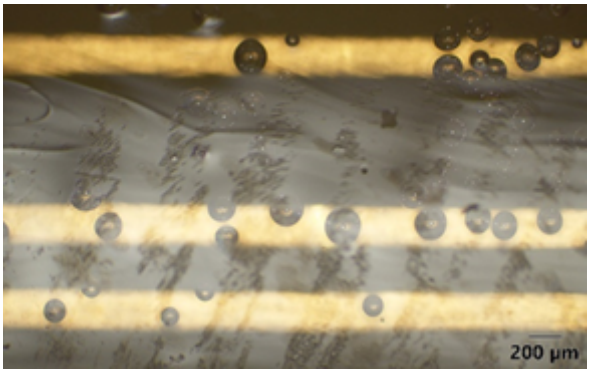

Fig. 1: PCB Encap. with Manually Mixed Epoxy

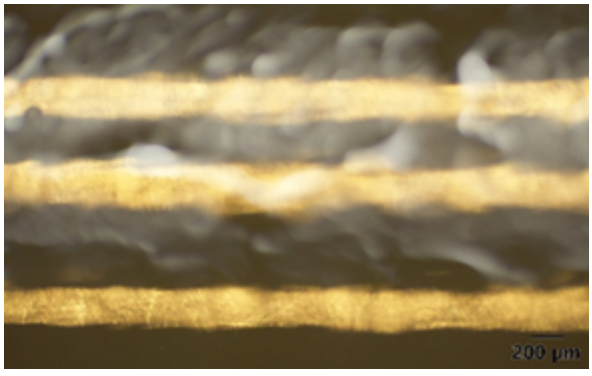

Fig. 2: PCB Encap. with Thinky Mixed Epoxy

One method of measuring pH in solution is with an ion-selective field effect transistor (ISFET). The ISFET is based on the metal-oxide-semiconductor field-effect transistor (MOSFET) and was first developed by Piet Bergveld in 1970 [2]. To extract the electrical signal for pH sensing, the ISFET chip is placed on a printed circuit board (PCB) which is then connected to a measurement system for recording. To protect the PCB and other components (wire-bonds, bond pads) from an array of different acidic and basic solutions (from pH 1 to 13), an epoxy is applied. Failure to apply the epoxy correctly, e.g. with trapped bubbles, to the PCB could lead to unreliable measurements due to leakage current, voltage breakdown, and oxidation of the PCB circuitry.

When preparing the two-part epoxy, it is important that the epoxy is thoroughly mixed which also leads to a significant number of trapped bubbles when mixed manually (Fig. 1).

When the two-part epoxy is mixed with the Thinky ARE-250 Mixer, the epoxy is nearly free of trapped bubbles due to the mixing/degassing from planetary and rotational motions (Fig. 2).

By mixing the two-part epoxy with the Thinky Mixer, reliable ISFET sensors for pH sensing are easily available for evaluation by potential partners and clients.

[1] Sorensen, S. P. (1909). On the measurement and the importance of hydrogen ion concentration during enzymatic processes. Biochemische Zerischrift, 131-304.

[2] Bergveld, P. (1970). Developement of an Ion-Sensitive Solid-State Device for Neurophysiological Measurements. IEEE Transactions on Biomedical Engineering, 70-71.