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Basic Research on Semiconductor Ion Sensors

The Ion sensor is a sensor which selectively responds to specific ions in liquid and generates an electrode potential corresponding to its concentration. It was widely used in the fields of the chemical industry and clinical medicine, and downsizing was requested. However, a device which simply downsized the common ion sensor was useless because instabilities such as noise increased, and response time took longer.

This difficult problem was solved by the invention of an ultracompact ion sensor with the use of IC technology by M. Matsuo, M. Esashi et al. The principle of the said device was to measure the ion concentration from changes in the drain current which occur due to the interface potential that arises between the liquid and the insulating film without using metal for gate electrodes of MOS field-effect transistors, directly immersing the insulating film into the liquid.

Because of this, it became user-friendly, e.g., ultracompact (tens – hundreds μm) and multiplexing was easy, response time was very short (100 ms), ideal insulation film for sensitive film was available, and the performance of ion sensors was remarkably improved, and accordingly this brought about the advancement of electrical engineering for medical uses and semiconductor device engineering.

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Pioneering Study on Integrated Circuit Technology

The bipolar LSI, the fastest at the time, was used for large electronic computers, and this began the introduction of very high-speed large-scale integrated circuits into the computer field. For this reason, the research and development of high-speed devices became active. Then, very high-speed logic circuits, called Non-Threshold-Logic (NTL), where the threshold value of each gate circuit in the logic block is not fixed and basic research on MOS device good for high integration were proposed and these efforts eventually led to 64K-bit very high-speed memory which ushered in a new era of very-large-scale integrated circuits.