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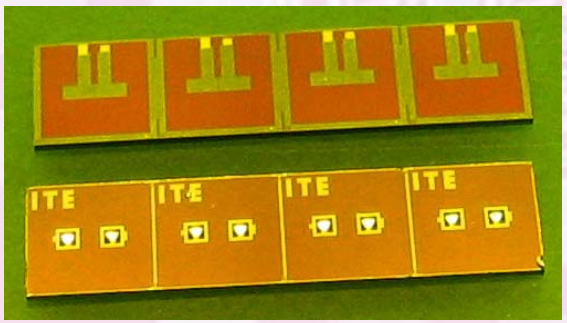
The family of Ion Sensitive Field Effect Transistor (ISFET) microsensors for pH measurements, analytical and biomedical applications, monitoring of ground water pollution



ISFET microsensors

Ion Sensitive Field Effect Transistor (ISFET) sensors, developed and fabricated at IET, were originated from the MOSFET structure in which the aluminum gate was replaced by the SiO_2/Si_3N_4 dielectric gate. The standard NMOS or P-well NMOS technology was implemented to form a family of ISFET sensors with different electrodes configuration, performance, and application possibilities.

ISFET sensor properties and performances are mainly applied for pH measurements. They may be also used as a base structure for a Chemical Field Effect Transistor (ChemFET) obtained by deposition on on the dielectric gate area a polyHEMA layer followed by siloprene-based ion-sensitive membranes. With these modifications the ChemFETs may be used for monitoring of ground water pollution. Several other applications are possible including biomedical and biochemical areas.

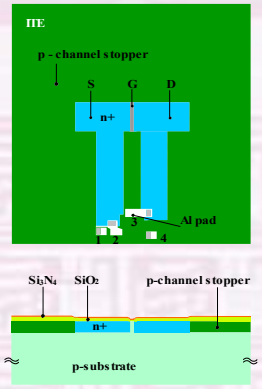


Fig. 1 FSC ISFET

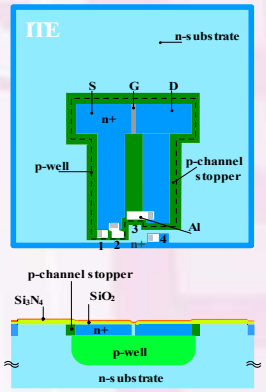


Fig. 2 P-well FSC ISFET

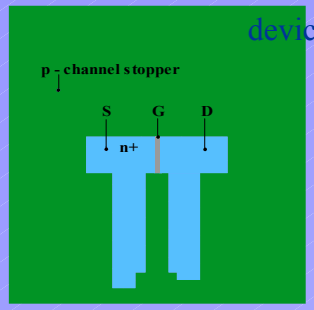
IET ISFETs Design Conceptions

❖ ***Front Side Connected (FSC) ISFET (Fig. 1).***

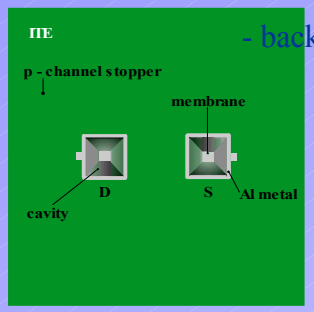
❖***P-well Front Side Connected ISFET (Fig. 2). This version has better eletrical performace due to P-well isolation of the active area.***

• Both devices require assembling on PCB dipstick (Fig. 3).

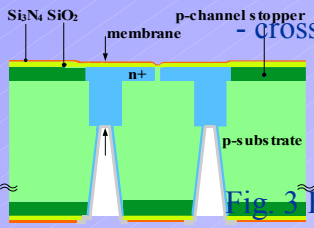
Fig. 3 PCB dipstick



device front side



- back side



- cross section

Fig. 3 BSC ISFET

❖ Back Side Connected (BSC) ISFET (Fig. 3)

S & D electrodes (Al covered cavities) at the backside of the chip separate measured signal from the front gate detecting side

The device requires special self-clamping head* (Fig. 4) allowing quick and simple applying without any assembly.

**/ designed and manufactured by Technical University of Warsaw at Chemical Dept.*

ISFET Technical and Electrical Data

Channel feature:

N-type, normally-on (depletion mode)

Dielectric gate composition: silicon dioxide-silicon nitride

Chip size: Length-4.9 mm, Width-4.9 mm, Thickness-380 µm

Cavity size & pitch: 0.8 × 0.8 mm, (0.6 × 0.6 mm-optional)

1.7 mm (only for BSC ISFET)

Electrical:

Recommended working point : V_{DS}=0.5 V, I_D=0.1 mA

evidencing quasi-Nernstian responses (s ≈ 48 mV/pH)

Reference maximum data:

V_{DS}=10 V, I_D=5 mA in whole pH range

typ. drain current I_{DSS}=0.3 mA @ V_{GS}=0 V & V_{DS}=0.5 V @ pH=7

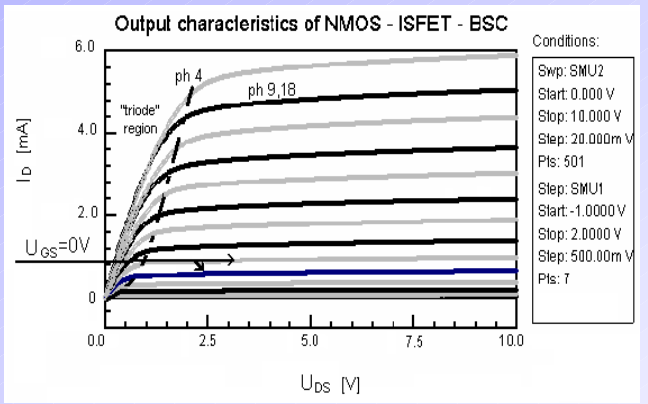
(this current is technologically controlled and on demand set in the range of 0.1-1 mA)

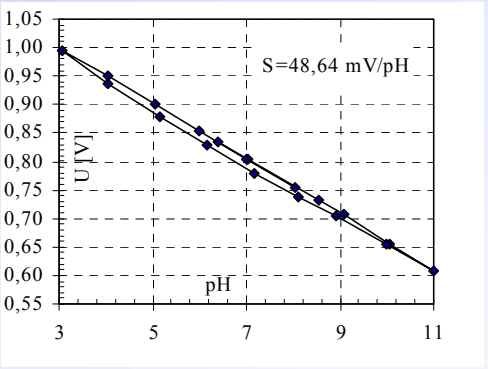
typ. drain current I_{DSS}=0.5 mA @ V_{GS}=0V & V_{DS}=2.5V @ pH=7

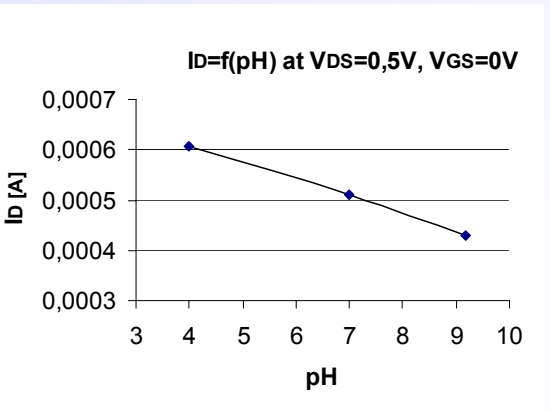
(this current is technologically controlled and on demand set in the range of 0.2-1 mA)

Fig. 4 Self-clamping head

Typical Electrical Characteristics







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