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On-chip post-processing fabrication techniques for extended gate isfet ph sensors

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An Ion Sensitive Field Effect Transistor (ISFET) is an electrochemical sensor based on a standard MOSFET, whose gate is replaced by the solution being measured and a reference electrode. The gate dielectric acts as an ion sensitive membrane, with a surface potential that is sensitive to the pH of the solution. If the ISFET is to be integrated with its instrumentation electronics on a single chip, it must be fabricated using a CMOS-compatible process. This normally takes advantage of the metallisation layers available in the process to bring the gate connection up to the surface of the integrated circuit so that the top passivation acts as the pH sensitive surface.

This paper reports post-processing techniques, applied to a foundry- fabricated CMOS chip, that create a new form of “Extended-Gate” ISFET design [1] that is not normally available in standard commercial foundry processes. An on-chip ISFET, fabricated on a 0.35µm commercial process, has been modified to form an extended gate ISFET with a large area pH sensitive top insulating layer (Fig. 1). The following multiple-step photolithographic post-CMOS process has been developed:-

Remove the existing top insulator by dry etching

Deposit and pattern a new top metal area

Deposit and pattern (or create via anodic growth) a new top insulator as the pH sensing layer

The post-processed chip is wired-bonded to a package, attached to a liquid chamber and finally encapsulated.

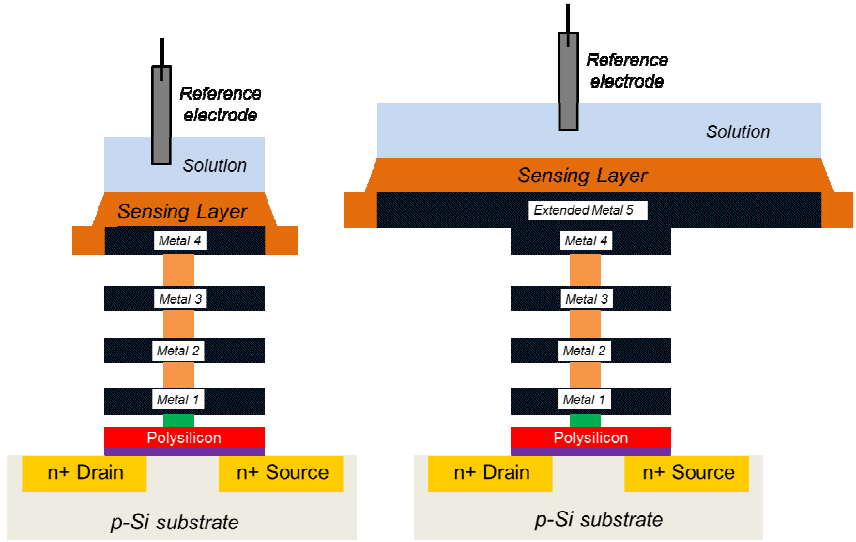

Figure 1: (a) Typical ISFET layout in a CMOS process (b) modified ISFET design.

The extended-gate ISFETs were tested for extended periods of time. The modified ISFET sensors respond well to changes in pH, verifying that the post-processing design was successful. Future work will explore fabrication techniques and ion-sensitive membranes that minimise and/or ameliorate drift in these measurements.

[1] L.L. Chi et al. Mat. Chem. Phys. , 63 (2000) 19-23

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