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Super Coupling Dual-gate Ion-Sensitive Field-Effect Transistors

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For more than four decades, ion-sensitive field-effect transistor (ISFET) sensors that respond to the change of surface potential on a membrane have been intensively investigated in the chemical, environmental, and biological spheres, because of their potential, in particular their compatibility with CMOS manufacturing technology. Here, we demonstrate a new type of ISFET with dual-gate (DG) structure fabricated on ultra-thin body (UTB), which highly boosts sensitivity, as well as enhancing chemical stability. The classic ion-sensitive field-effect transistor (ISFET) has been confronted with chronic problems; the Nernstian response, and detection limit with in the Debye length. The super-coupling effects imposed on the ultra thin film serve to not only maximize sensitivity of the DG ISFET, but also to strongly suppress its leakage currents, leading to a better chemical stability. This geometry will allow the ISFET based biosensor platform to continue enhancement into the next decade.

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Table 1. Sensing properties of the DG ISFETs with various body thicknesses extracted from the DG measurement.

Body thickness	Sensitivity (mV/pH)	Linearity (%)	VH (mV)	Drift rate (mV/h)	VHerror (%)	Drift rateerror (%)
100 nm	124	98.29	102	12.45	83.26	10.04
50 nm	170	98.62	34.66	12.04	20.39	7.08
20 nm	258	98.81	54.49	13.34	21.12	5.17
5 nm	416	99.79	63.56	19.65	15.29	4.72