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Two-Dimensional Materials: from Contact to Device Applications

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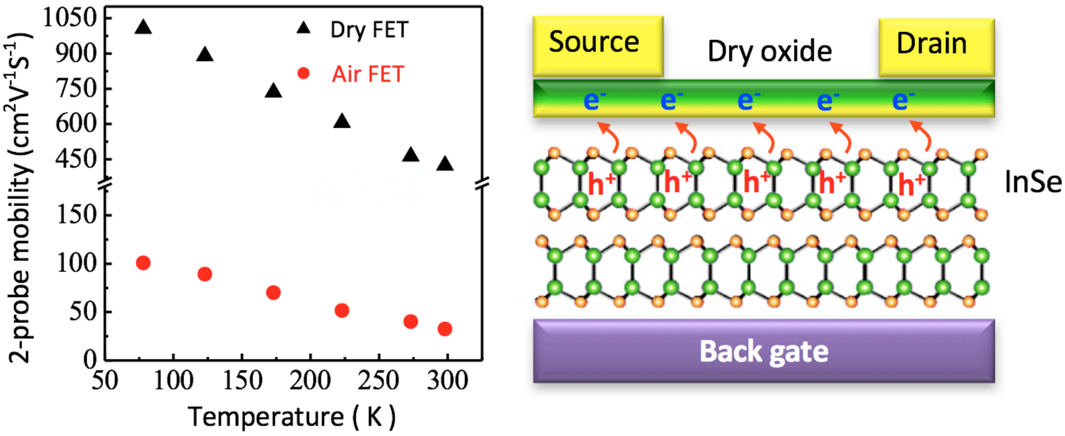
ABSTRACT

In search of high-performance field-effect transistors (FETs) made of atomic thin semiconductors, indium selenide (InSe) has hold great promise due to its high intrinsic mobility and moderate electronic band gap (1.26 eV). Yet the performance of InSe FETs is decisively determined by the surface oxidation of InSe taking place spontaneously in ambient conditions, setting up a mobility ceiling and causing an uncontrollable current hysteresis. Encapsulation by hexagonal boron nitride (h-BN) has been currently used to cope with this deterioration. Here, we provide insights into the role of surface oxides played in device performance and introduce a dry-oxidation process that forms a dense capping layer on top, with which InSe FETs exhibit a record-high two-probe mobility without the use of h-BN encapsulation or high-κ dielectric screening. Ultrahigh current on/off ratio of $>10^8$ and current density of 365 μA/μm can be readily achieved without elebrate engineering of drain/source contacts or gating technique. The high performance of InSe FETs with thin dry oxide is attributed to the effective unpinning of the Fermi level at the metal contacts, resulting in a low Schottky barrier height of 40 meV in an optimized channel thickness. Applications for electronic and optoelectronic devices based on 2D materials will also be discussed.



1050
900
750
600
450
150
100
50
0
50
100
150
200
250
300
Dry FET
Air FET
2-probe mobility (cm2V-1S-1)
Temperature (K)
Source
Dry oxide
Drain
e-
h+
InSe
Back gate