ABSTRACT:

Sensing responses of an open-gate liquid-phase sensor fabricated on undoped-AlGaN/GaN high-electron-mobility-transistor (HEMT) structure are investigated in aqueous solution. In air-exposed ambient, the open-gate undoped AlGaN/GaN HEMT shows the only presence of linear region of currents while Si-doped AlGaN/GaN shows linear and saturation regions of currents, very similar to those of gated devices. This seems to show that very low Fermi level pinning by surface states exists in undoped AlGaN/GaN sample compared to Si-doped sample. In aqueous solution, the typical current-voltage (I-V) characteristics of HEMTs with reasonably good gate controllability are observed. The potential of the AlGaN surface at the open-gate area is effectively controlled via aqueous solution by Ag/AgCl gate electrode. The open-gate undoped AlGaN/GaN HEMT structure is capable of distinguishing pH level in aqueous electrolytes and exhibits linear sensitivity, where high sensitivity of 1.9 mA/pH or 3.88 mA/mm/pH at drain-source voltage, VDS = 5 V is obtained. Due to large leakage current where it increases with the negative gate voltage, the Nernstian's like sensitivity cannot be determined as what commonly reported in literatures. This large leakage current may be caused by the technical factors rather than the characteristics of the devices themselves. Suprisingly, although there is imperfection in the device preparation, the fabricated devices work very well in distinguishing the pH levels. Suppression of current leakage is likely to improve the device performance. The fabricated open-gate undoped-AlGaN/GaN structure is expected to be suitable for pH sensing application.