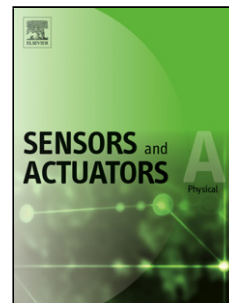


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Illumination impact on monolayer MoS₂ chemical sensor arrays

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Highlights

- Intrinsic MoS₂ without photon absorption exhibits ultrahigh sensitivity.
- Illumination reduces the response of MoS₂ by up to 95% and changes sensing mechanism.
- Integration of intrinsic MoS₂ ion sensors with outstanding selectivity was realized.

Abstract: Molybdenum disulfide (MoS₂) is a promising nanomaterial for chemical sensing due to its exceptional properties. However, it is extremely sensitive to illumination and converts the energy of photons absorbed into photocurrent, which has hampered efforts to explore the sensing performance and underlying transduction mechanism of intrinsic MoS₂. Here we systematically explored the sensing behavior of intrinsic MoS₂ and the impact of illumination. In dark environment, MoS₂ demonstrated record-high sensitivity reaching 1030 for pH change by 1 unit. Its photoresponsivity (1300 A/W) can be tuned by ions in electrolyte. Photon absorption not only substantially reduced the response of intrinsic MoS₂ by up to 95%, but also changed its sensing mechanism. After revealing the remarkable sensing performance of intrinsic MoS₂, we demonstrated the possibility of the integration of MoS₂ sensors functionalized with ionophore. Multiplex trace detection of Na⁺, Hg²⁺, and Cd²⁺ was realized on a 1 cm×1 cm chip with tunable sensitivity by illumination. The ion sensing results demonstrated outstanding selectivity, repeatability, detection limit (50 nM), response rate (10 s), and the capability of detecting target ions in environmental water samples. Our results show the prominent advantages of intrinsic MoS₂ as a chemical sensing material.

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