利用二維材料克服摩爾定律極限的電子元件與自供電感測元件基礎研究與開發

Development of electronics and self-powered sensors based on 2D materials to overcome the limit of Moore's law

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In this two-year project, several practical guidelines and future visions regarding the goal that utilization of two-dimensional (2D) materials to overcome the limits of Moore's law was demonstrated. As for the breakthrough of the *More Moore* condition, one of the most severe challenges that wrinkles generated during the transfer process have been completely solved by adjusting wettability of solvent, which reduces the density of scattering center and results in high carrier mobility of MoS_2 transistor as shown in Figure 1[1]. Moreover, several guidelines were demonstrated that promote the intrinsic properties of 2D materials in functional applications, providing a potential alternative candidate of *More than Moore* condition. First, photon- and gas-sensitive $SnSe_2$ thin films were integrated to floating-gate circuits, which promotes the sensitivity as shown in Figure 2 [2,3]. Second, hierarchical MoS_2 and WS_2 structures as well as heterojunction were demonstrated to enhance the optical response via the engineering of electronics structures as shown in Figure 3 [4,5]. Finally, a prototype of a gas sensor based on $SnSe_2$ was developed. Since the operation power is significantly lower than typical products, a self-powered module provided by photovoltaic cells was achieved, which makes it beneficial in applications of the internet of things.

References

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Figure 1. Winkle-less transfer of 2D materials by utilizing adjustable wettability assisted transfer technique

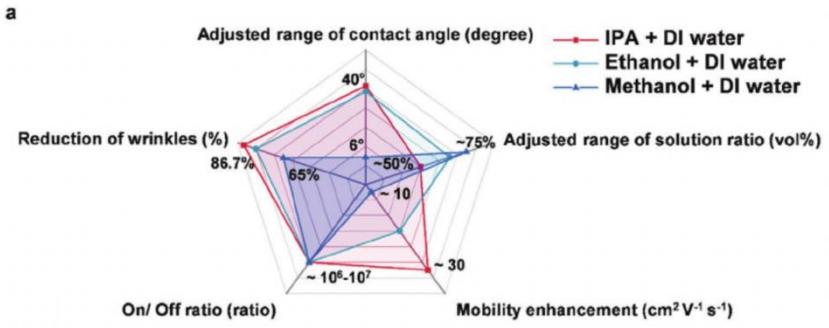

Figure 2. Efficient gas sensors based on 2D materials integrated to floating gate circuits.

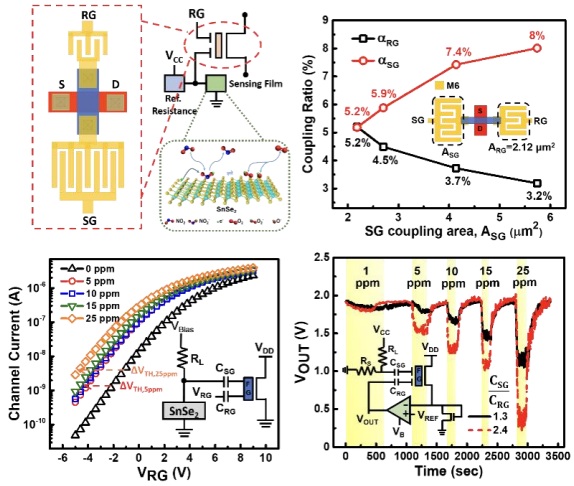

Figure 3. Bifunctional sensors based on 2D materials and heterojunction.