

PEC based Self powered Photodetector and sensors using Hydrogen-terminated 2D Germananes and silicene

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The last two decades have belonged to various 2D materials such as graphene, black phosphorus (BP), and transition metal compounds. These 2D materials offer a wide range of applications ranging from sensors, photodetectors, energy storage, catalysis, to health monitoring.^[1-3] Recently, 2D monoelement materials (Si, Ge, Sn, and other group 14 elements), also referred to as "Xen", have attracted great scientific and technological interest and have become recent favourites of scientific research thanks to their structure comparable to graphene, band opening by spin-orbit coupling, tunable band gap, and 2D quantum confinement effect, and offer great future potential.^[4] In particular, germanane silicane (the single layer of germanium and silicon),^[5] which exhibits mixed sp²/sp³ hybridization with a predicted compatible band gap of about 1.65 eV (GeH) for optoelectronic applications, shows excellent carrier mobility and quantum Hall effect. Here, we have successfully exfoliated a layer with hydrogen terminated germanene and silicene composition (Ge-H, Ge_{0.75}Si_{0.25}H and Ge_{0.5}Si_{0.5}H) of alloyed Ca(Si_{1-x}Ge_x)₂. The monoelement photoelectrochemical (PEC) device exhibited self-powered broadband photodetection in the range of 385 to 940 nm with unprecedented responsivity and detectivity on the order of 168 μA W⁻¹ and 3.45×10⁸ cm Hz^{1/2} W⁻¹, respectively, under the illumination of 420 nm LED light. In addition, 2D germanene and silicene showed excellent sensing capability for organic vapours with ultrafast response and recovery time of less than 1 s. Finally, the photocatalytic activity in the form of hydrogen evolution reaction was investigated due to the suitable band alignment and catalytic activity. This novel material with the mentioned fascinating phenomenon will pave the way for practical future applications in optoelectronics and sensing.

References

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Figures

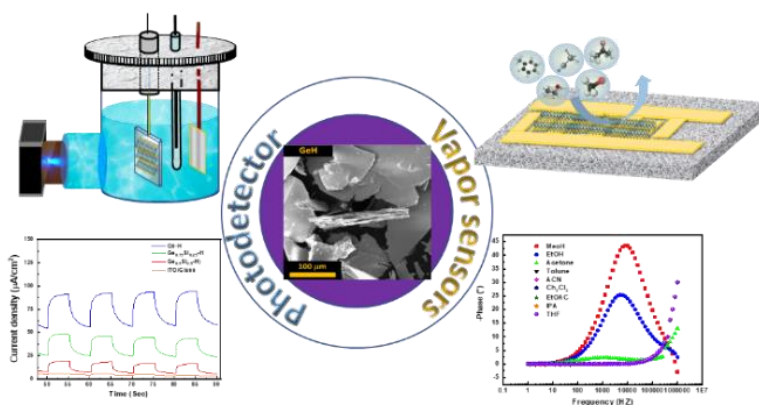


Figure 1: Hydrogen terminated two-dimensional germanane/silicane composites, a self-powered, ultra-sensitive and ultra-fast broadband photodetector, and sensors