Mixed dimensional ultra-wide bandgap p-n heterojunction of diamond/β-Ga_2O_3 for a solar-blind photodiode

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β-Ga_2O_3 and diamond have been studied as novel ultra-wide bandgap (UWBG) semiconductors for power electronics and optoelectronics with outstanding material properties. However, the potential of UWBG semiconductors has not been fully understood since it is difficult to form p-n homojunctions. Due to the difficulty in p-type and n-type doping for β-Ga_2O_3 and diamond respectively, they can be mutual ideal candidates for constructing the p-n heterojunctions. The integration of diamond with extremely high thermal conductivity also poses the merits of effective heat dissipation of β-Ga_2O_3 with low thermal conductivity.

UWBG p-n heterojunction based on p-diamond substrate and n-type exfoliated β-Ga_2O_3 nano-layer was demonstrated. The UWBG p-n heterojunction exhibited excellent rectification ratio and high reverse breakdown voltage. With cut off wavelength shorter than 280 nm (UV-C), the p-n heterojunction also showed outstanding solar-blind photoresponse performances including high responsivity and high rejection ratio.