

Photoelectrochemical properties of full composition $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{Si}$ photoanodes

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Recently $\text{In}_x\text{Ga}_{1-x}\text{N}$ ($x=0-1$) thin films and nanostructures have attracted considerable interest in the field of solar assisted water splitting.¹ As a standalone photoelectrode it is very appealing due to its direct, tunable bandgap covering nearly the entire solar spectrum (Fig. 1a), high absorption coefficient and mobility, along with near-perfect band-edge potentials. Moreover, because of the special bands alignment it can be grown on p-Si photocathode and exhibit vertical conductivity without complex tunnel junction.² These facts open a possibility to achieve high efficiency, relatively cheap InGaN/Si-based two-photon tandem devices for water splitting.

Previously, we have demonstrated that high quality, compact, and chemically homogeneous $\text{In}_x\text{Ga}_{1-x}\text{N}$ layers can be grown, over entire compositional range, directly on Si(111) by plasma-assisted molecular beam epitaxy.³ The performance of $\text{In}_{0.4}\text{Ga}_{0.6}\text{N}$ -based photoanodes, the most important for tandem devices, was also evaluated.^{4,5}

In this work we study the photoelectrochemical properties of $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{Si}$ thin films over entire alloy composition range. A correlation between band gap and onset potential for compositions of $x=0-0.45$ is established (Fig. 1b). For higher x values, $\text{In}_x\text{Ga}_{1-x}\text{N}$ suffers from a high unintentional n-type doping, which results in metal-like behavior. The use of magnetron sputtered Ni- and NiO-based catalysts is discussed.

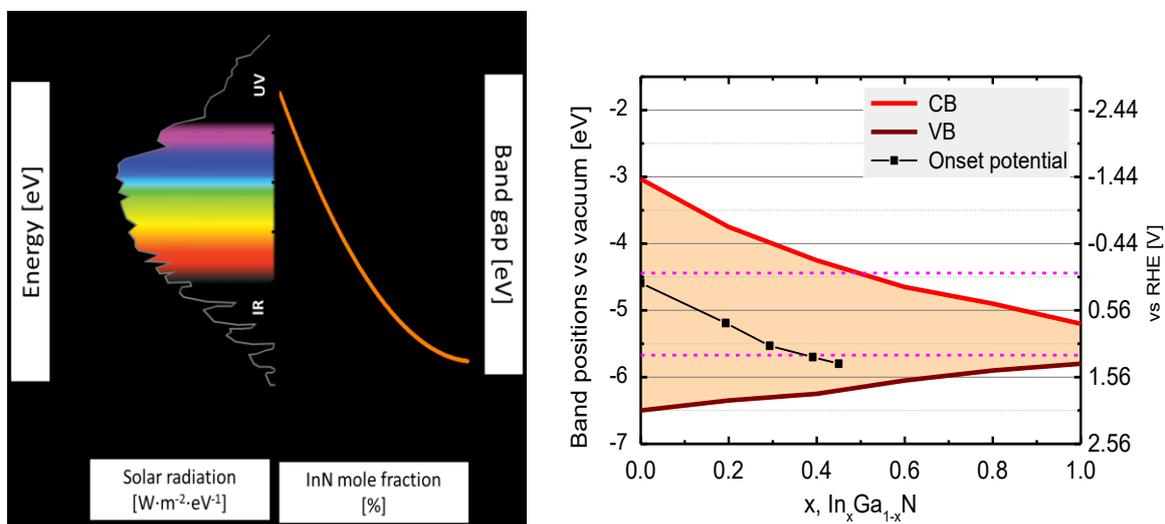


Fig. 1. (a) Solar spectrum overlap with $\text{In}_x\text{Ga}_{1-x}\text{N}$ band gap. (b) Onset potential of $\text{In}_x\text{Ga}_{1-x}\text{N}$ film photoanodes as a function of the alloy composition.

References

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