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Evaluating the performance of GaN and InGaN/GaN core-shell nanorods structures as photo anodes in photoelectrochemical water splitting

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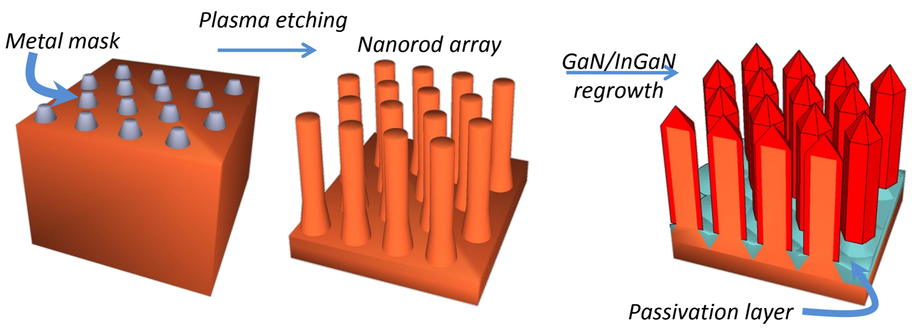
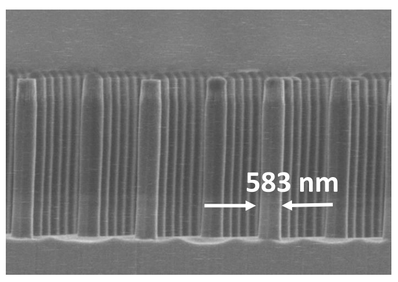
Abstract

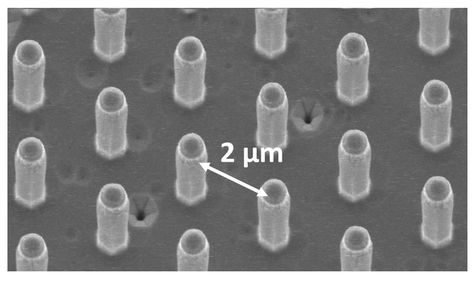
InGaN/GaN core-shell structure have gained increasing interest as photo anodes for water-splitting due to their adjustable band gap, which can be tuned to absorb a wide range of the solar spectrum. Although promising, their stability in liquid environments has been hindering their use in photoelectrochemical (PEC) water-splitting. In an attempt to understand and evaluate these instabilities, we tested GaN nanorods in different electrolytes. Cyclic voltammetry and time dependant photocurrent data are presented, together with SEM images and EDX, before and after etching, to show the effect of the tests on the specimens. Despite these instabilities, our initial results, obtained on InGaN/GaN core-shell nanorods structures showed promising results.

Fabrication process

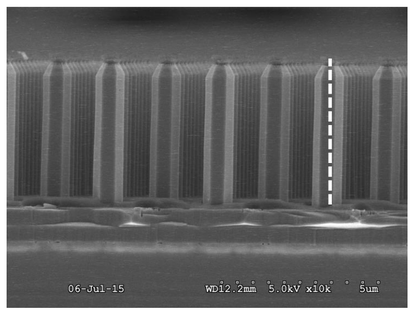


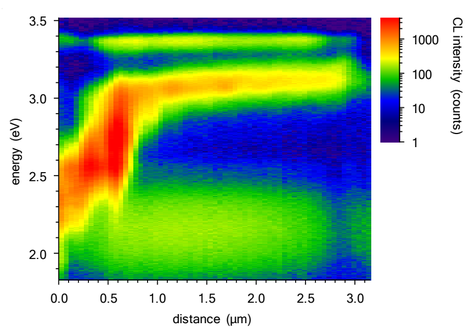
GaN nanorods





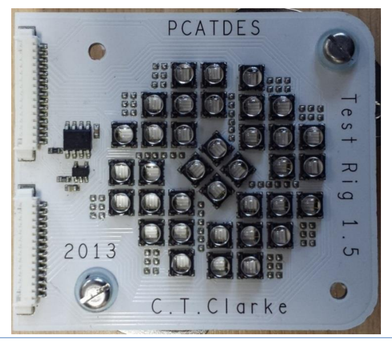
Line spectrum along the length of the InGaN/GaN core-shell structure





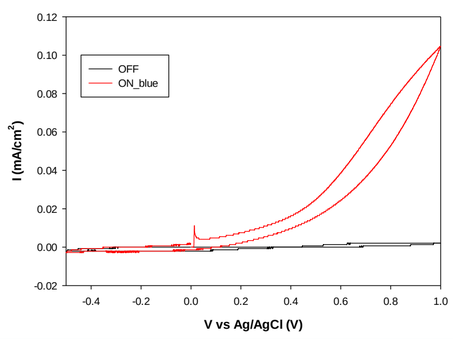
Photoelectrochemical (PEC) measurements

- 3-electrode electrochemical system
- Ag/AgCl reference electrode and a platinum wire as a counter electrode in 0.1M Na_2SO_4 electrolyte
- 6 wavelengths→ UV to visible light
- Homogeneous illumination



InGaN/GaN core-shell nanorods

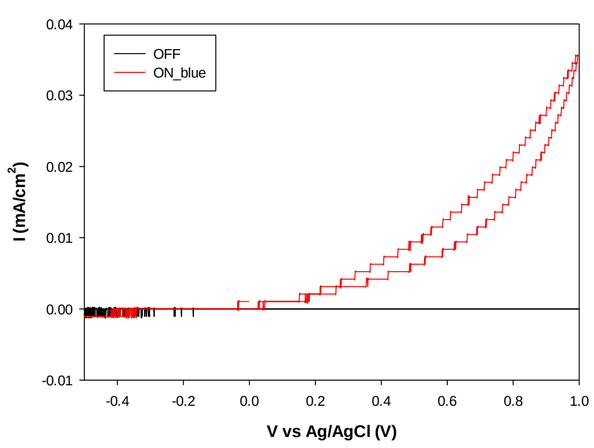
InGaN/GaN under blue light (451.22nm)



Wavelength (nm)	IPCE (%) 0 V vs SHE	IPCE (%) 0.74 V vs SHE
451.22	1.23	13.4
527.18	1.34	10.7
593.57	0	0.84
629.62	0	0.18

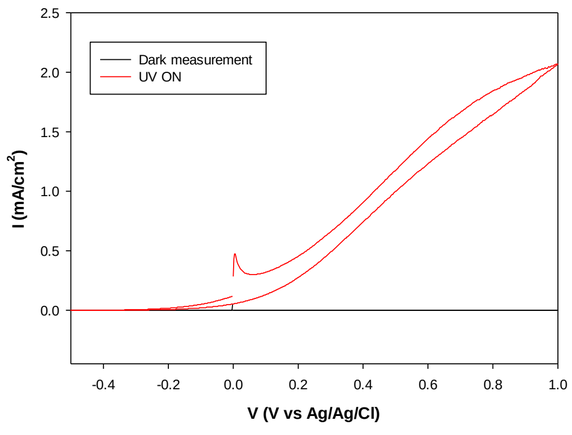
After a few runs…

Reduced photocurrent under blue light (451.22nm)

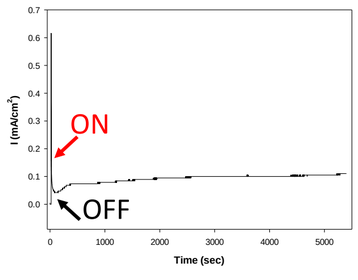


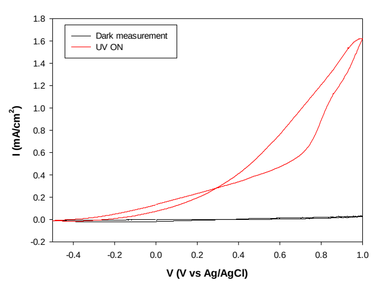
GaN nanorods

GaN under UV light (368 nm)

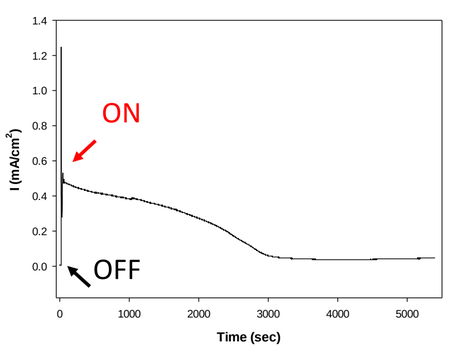


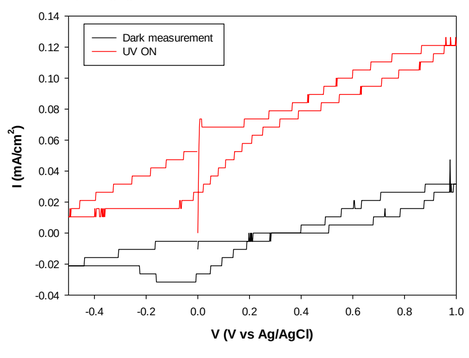
At 0 V vs SHE

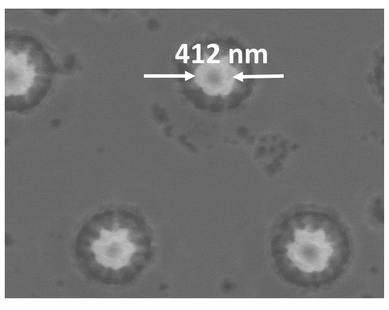




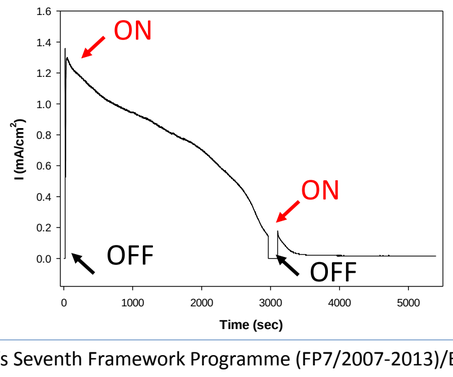
At 0.6 V vs SHE

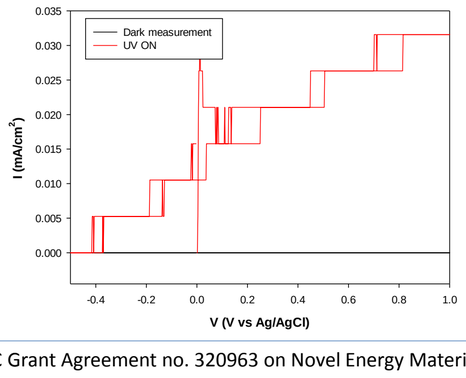


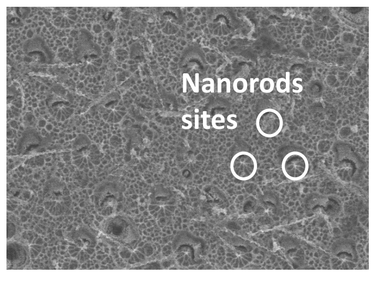




At 1 V vs SHE







- Electrochemically stable at 0 V vs SHE.
- Nanorods etched when potential is applied
- Test different electrolyte

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