

## Electronic Supplementary Information

# Producing green hydrogen in an efficient way using a nexus of waste-biomass derived catalyst and cost- effective & scalable electrode platform

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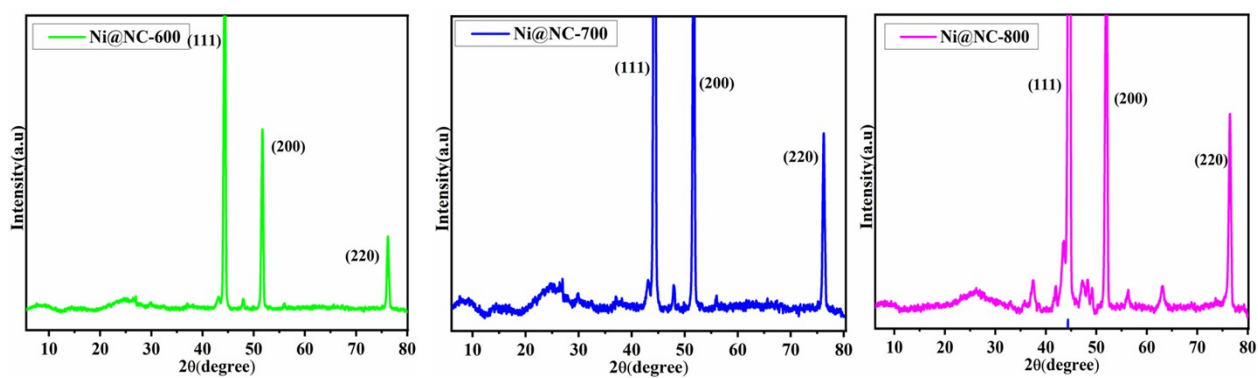
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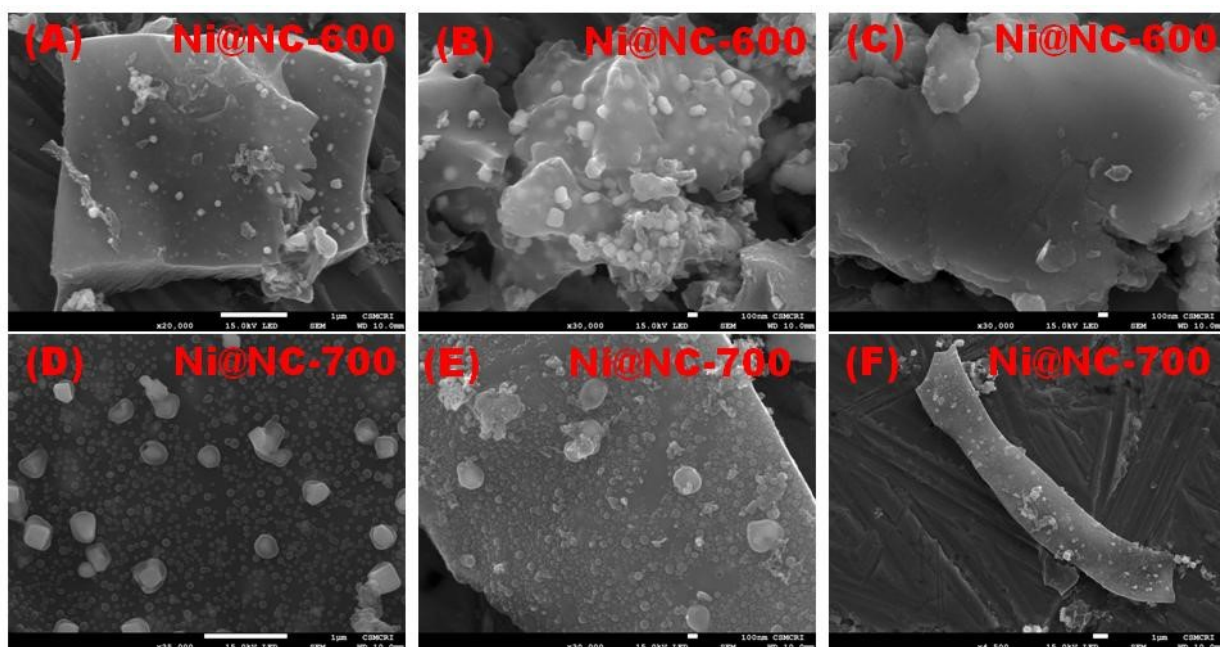
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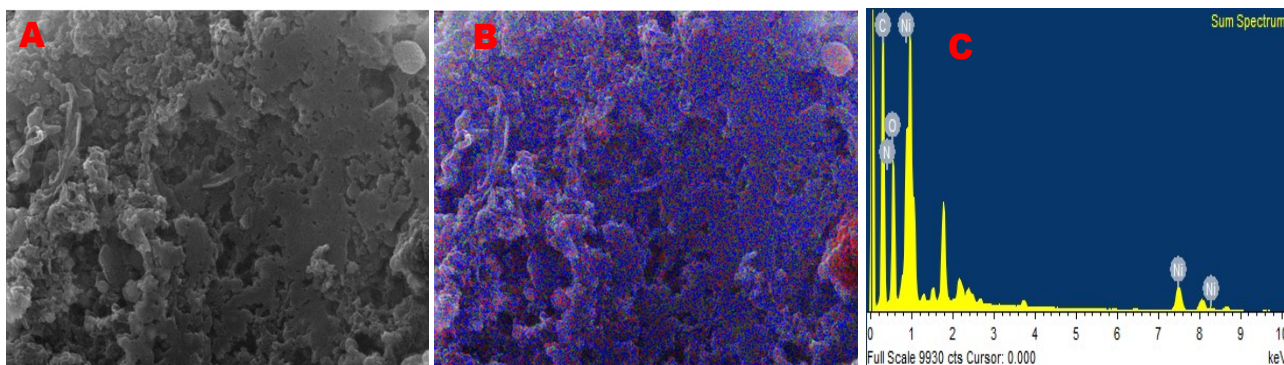
*E-mail: [dnsrivastava@csmcri.res.in](mailto:dnsrivastava@csmcri.res.in), [ankush@csmcri.res.in](mailto:ankush@csmcri.res.in)*



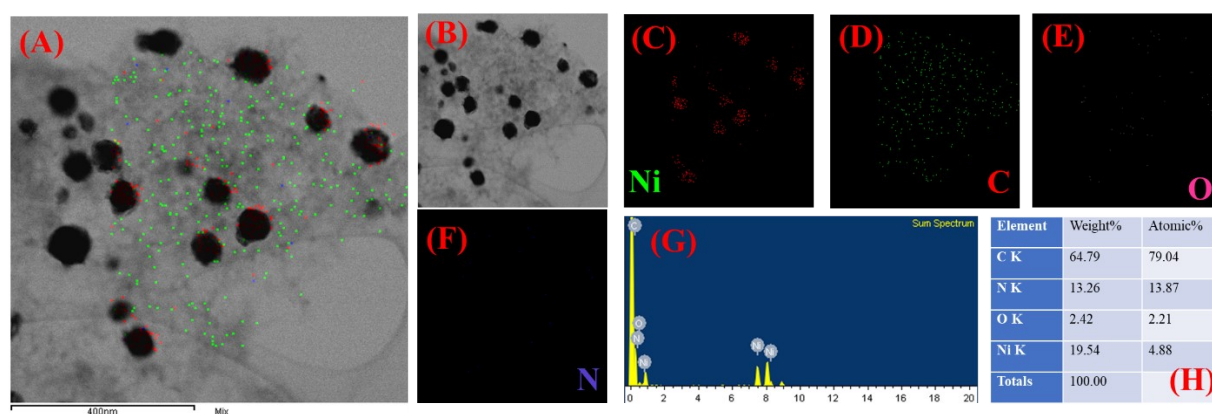
**Figure S1.** Zoom PXRD spectra of synthesized electrocatalyst.



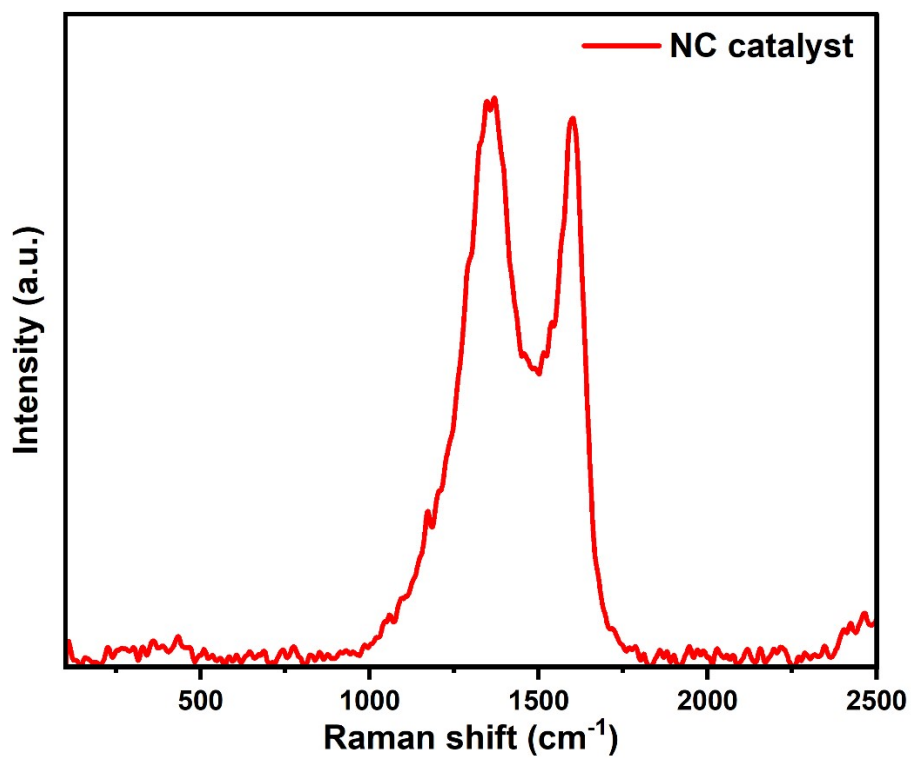
**Figure S2.** Scanning electron microscopy (SEM) image of Ni@NC-600 (A-C), Ni@NC-700 (D-F)



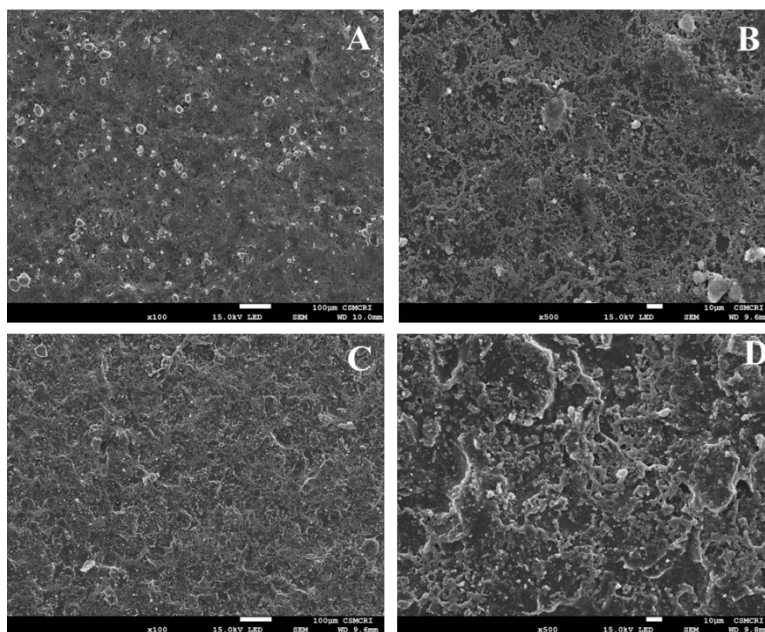
**Figure S3.** Scanning electron microscopy (SEM) image (A), Surface elemental mapping (B), EDX spectra of Ni@NC-800(C).



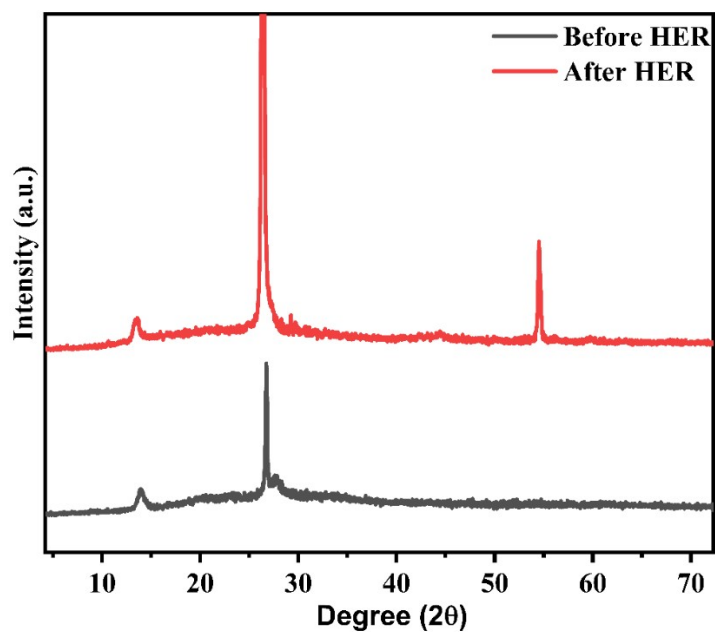
**Figure S4.** (A) Elemental mapping of the mixture of Ni, C, N and O, (B) electron images (C) Oxygen (D) Carbon, (E) Oxygen, (F) Nitrogen. (G) EDAX spectra of Ni@NC-800 (H) Table of elemental content Ni@NC-800.



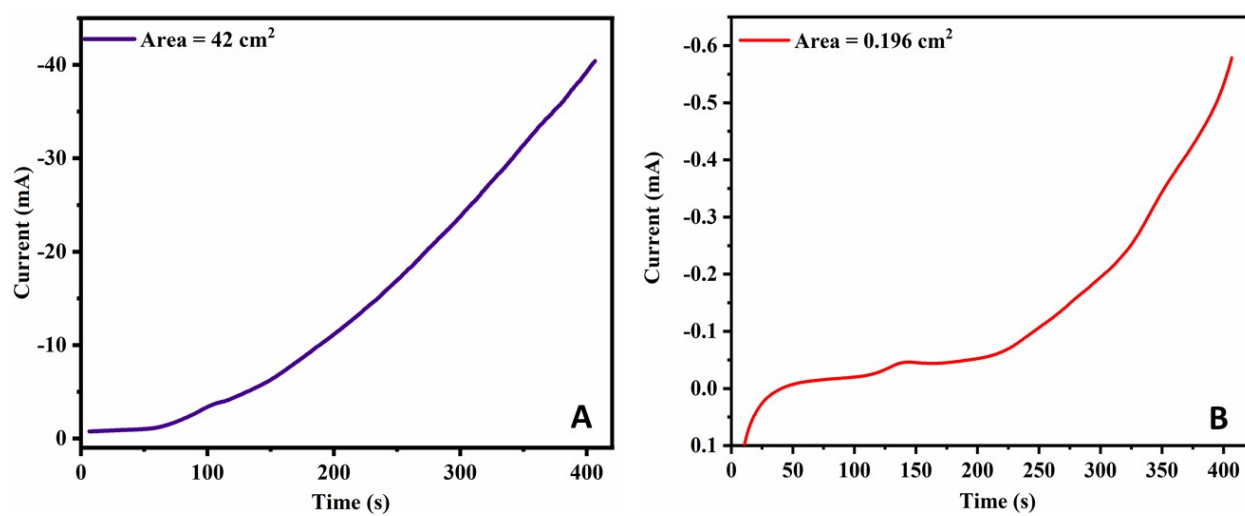
**Figure S5:** Raman spectra of NC catalyst.



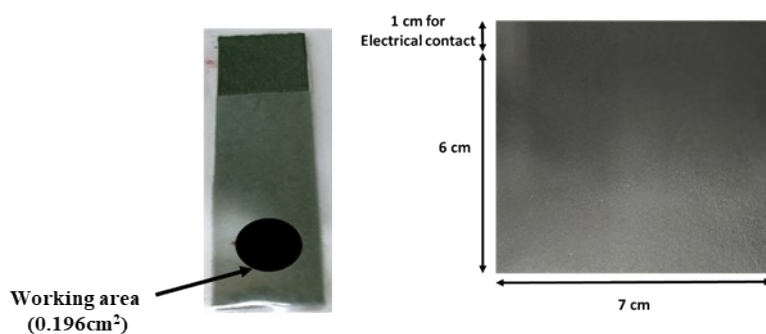
**Figure S6:** SEM analysis of Ni@NC-800 modified PCE (A,B) before, and (C,D) after the HER experiments.



**Figure S7:** XRD spectra of Ni@NC-800 modified PCE before, and after the HER experiments.



**Figure S8.** Time vs. current plot obtained from LSV (A) Ni@NC-800 modified PCE (area = 42 cm<sup>2</sup>); (B) Ni@NC-800 modified PCE (area = 0.196 cm<sup>2</sup>).



**Figure S9.** Photograph of Laminated Plastic Chip Electrode (area = 0.196 cm<sup>2</sup>) for small scale experiment and Plastic chip electrode (area = 42 cm<sup>2</sup>) for large scale experiment.

**Table S1. Comparison of electrochemical performance with another reported electrocatalyst**

Electrocatalyst	Electrolyte	Electrode	Overpotential(mV vs RHE) at 10mAcm <sup>-2</sup>	Reference
Ni@NC-800	0.5 M H <sub>2</sub> SO <sub>4</sub>	PCE	400	This work
Few-layered MoS <sub>2</sub> nanosheets	0.5 M H <sub>2</sub> SO <sub>4</sub>	Glassy Carbon Electrode	540	1
ON-CNF	0.5 M H <sub>2</sub> SO <sub>4</sub>	Glassy Carbon Electrode	490	2
Ni <sub>3</sub> S <sub>2</sub> /MWCNT	1 M KOH	Glassy Carbon Electrode	480	3
Ni <sub>3</sub> S <sub>2</sub>	0.5 M H <sub>2</sub> SO <sub>4</sub>	Glassy Carbon Electrode	832	4
Ni <sub>3</sub> S <sub>2</sub> -Ni	0.5 M H <sub>2</sub> SO <sub>4</sub>	Glassy Carbon Electrode	320	4
Ni@NC	0.5 M H <sub>2</sub> SO <sub>4</sub>	Glassy Carbon Electrode	370	5
Ni(OH) <sub>2</sub> /TM	1 M KOH	Ti Mesh	537	6

## References

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