Deep eutectic solvent assisted electrodeposition of NiCu alloy on the surface of stainless-steel mesh: Unveiling Its potential for water splitting reactions

Philominrajan Maria Viyanni [a] and Mathur Gopalakrishnan Sethuraman [a*]

a, a* Department of Chemistry, The Gandhigram Rural Institute – Deemed to be University, Gandhigram, Tamil Nadu, India.

Abstract

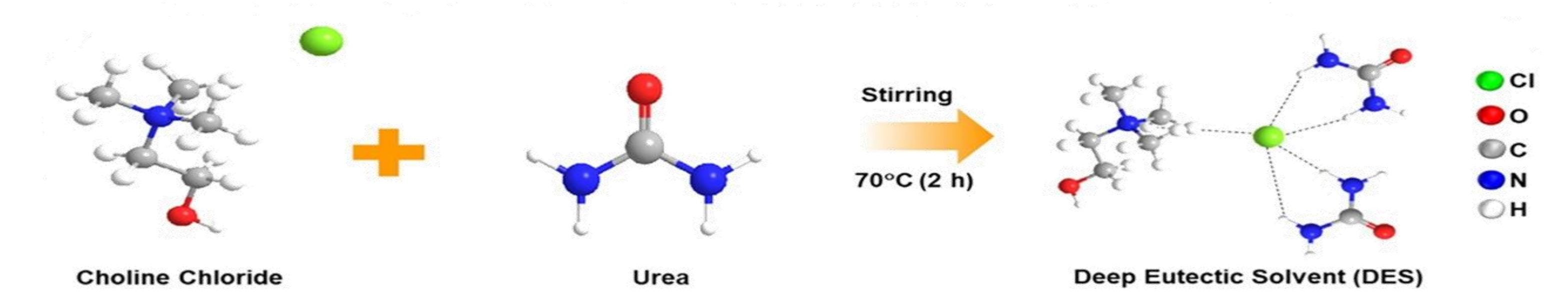
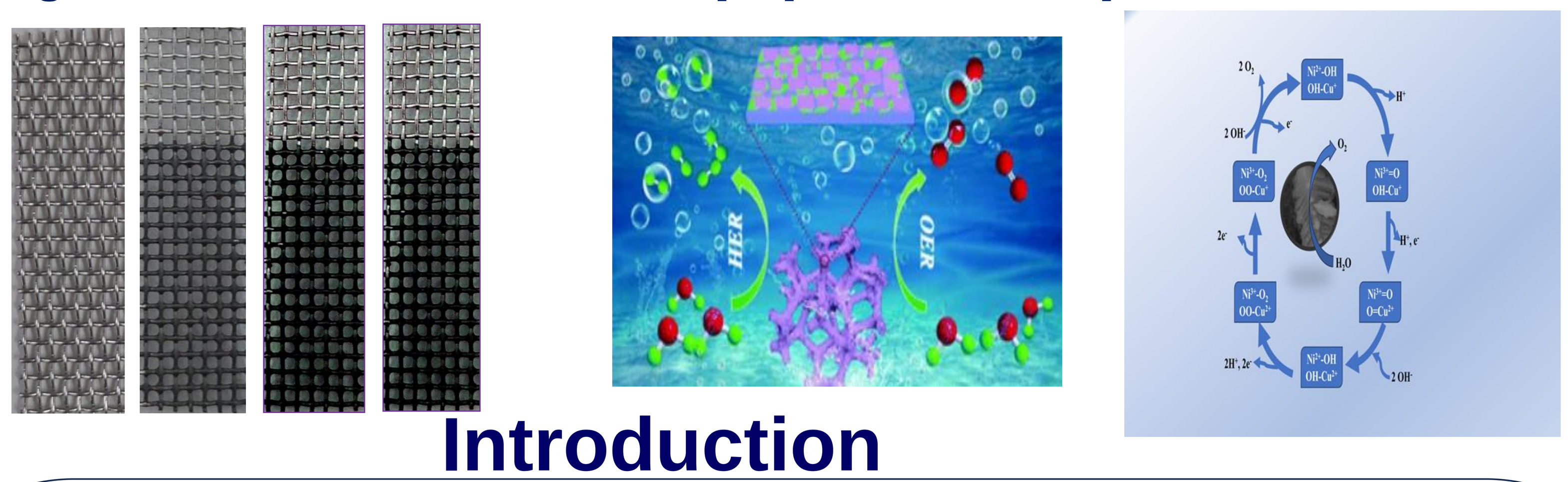
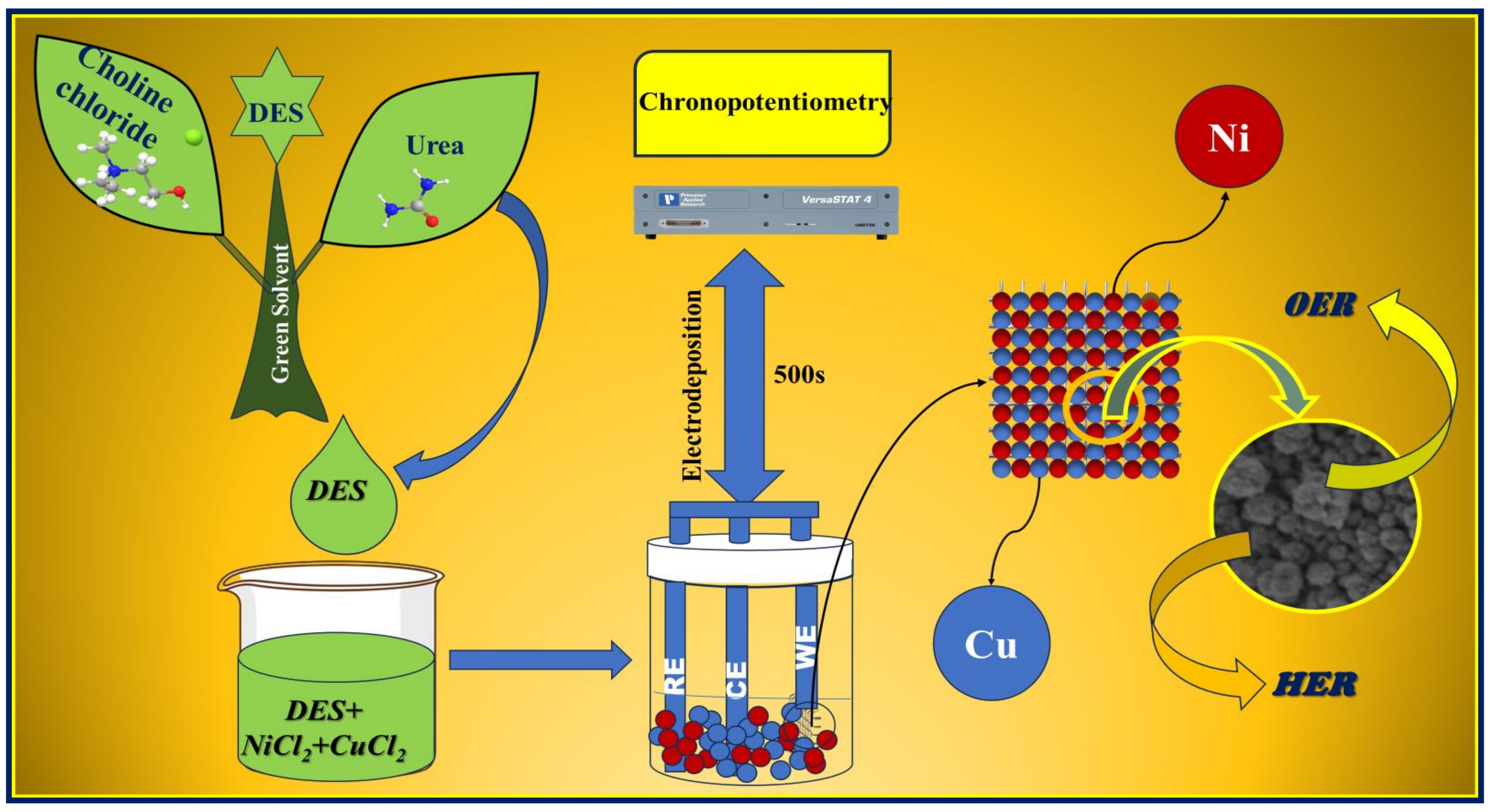


Fig.1 Schematic illustration of the preparation of Deep eutectic solvent



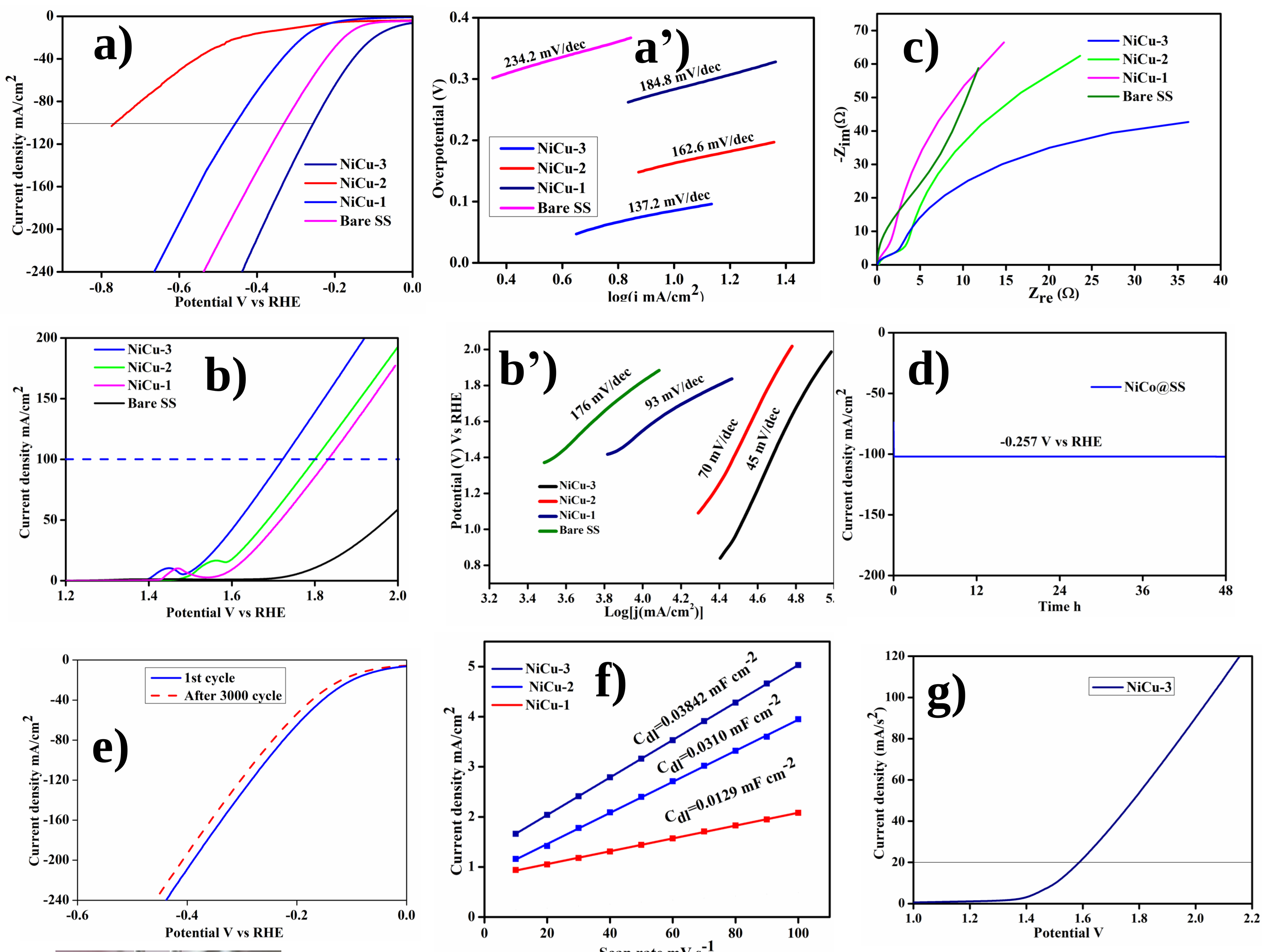
Experimental details



Introduction

- Today the global need for green and renewable energy sources as environmental impacts have changed widely with the steady decline of fossil fuels.
- The production of green fuel hydrogen through water splitting has emerged as a viable strategy for generating electrical energy from hydrogen.
- The O-O bond breaking and electron transfer involved in the half-reaction (OER) process result in slow reaction and high energy barrier, which has become the main bottleneck in the context of wide application.
- The main problem encountered today in water separation involves the insufficient kinetics of oxygen evolution reactions (OER), which requires a large amount of energy to overcome the electron-transfer barrier
- To overcome this issue, several precious metal electrocatalysts have been utilized.
- Deep eutectic solvents are made from two or more solids that form a eutectic mixture through hydrogen bonding, which consists of two main parts, a Hydrogen Bond Donor (HBD) and a Hydrogen Bond Acceptor (HBA)
- Compared with the aqueous electrolysis process, the DES-based electrodeposition process avoids the generation of hydrogen and other by-products
- Nickel is widely applied as an electrode material for the WSR. Nickel combined with coper improves the chemical, mechanical, electrochemical, and structural stability

Results



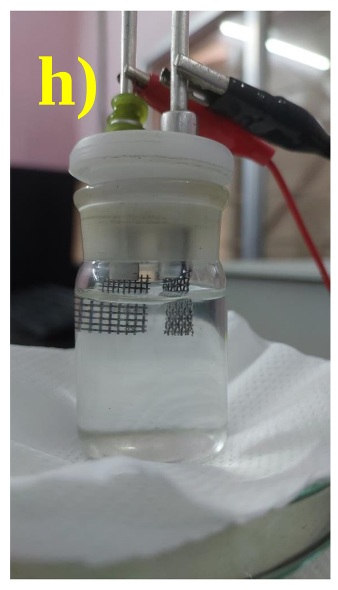


Fig.5. a and b are the LSV profile of NiCu@SS, a' and b' are the Tafel slope, c) Impedance spectrum of NiCu@SS in 1 M KOH, d) Chronoamperometry Stability test, e) LSV profile of NiCu@SS first cycle and 3000th Cycle, f) ECSA of NiCu@SS and g) Over all cell voltage of water splitting reaction

Material Characterisation

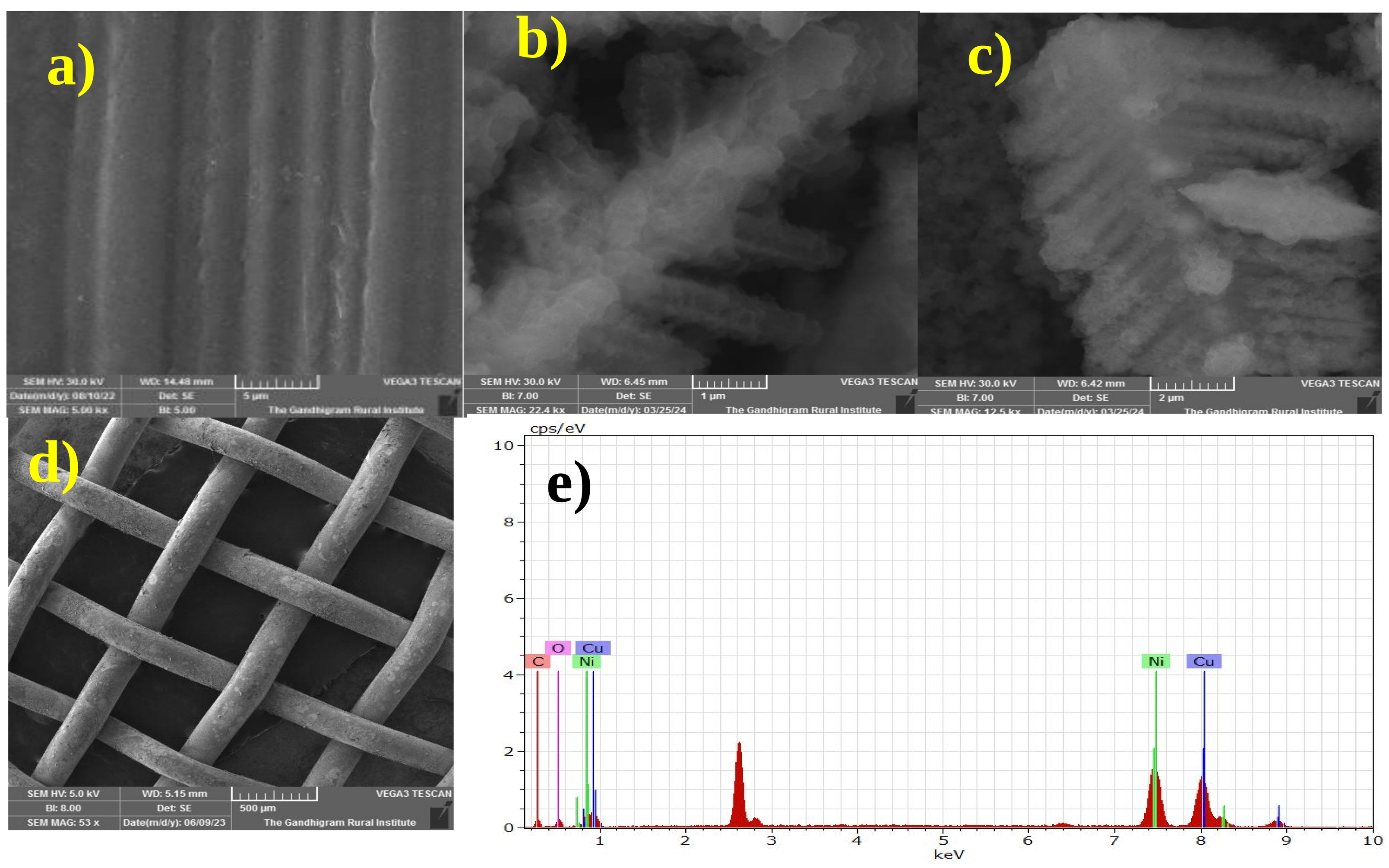


Fig.2 SEM images of a) Bare SS b-d) NiCu@SS with different magnifications e) EDX spectrum of NiCu@SS

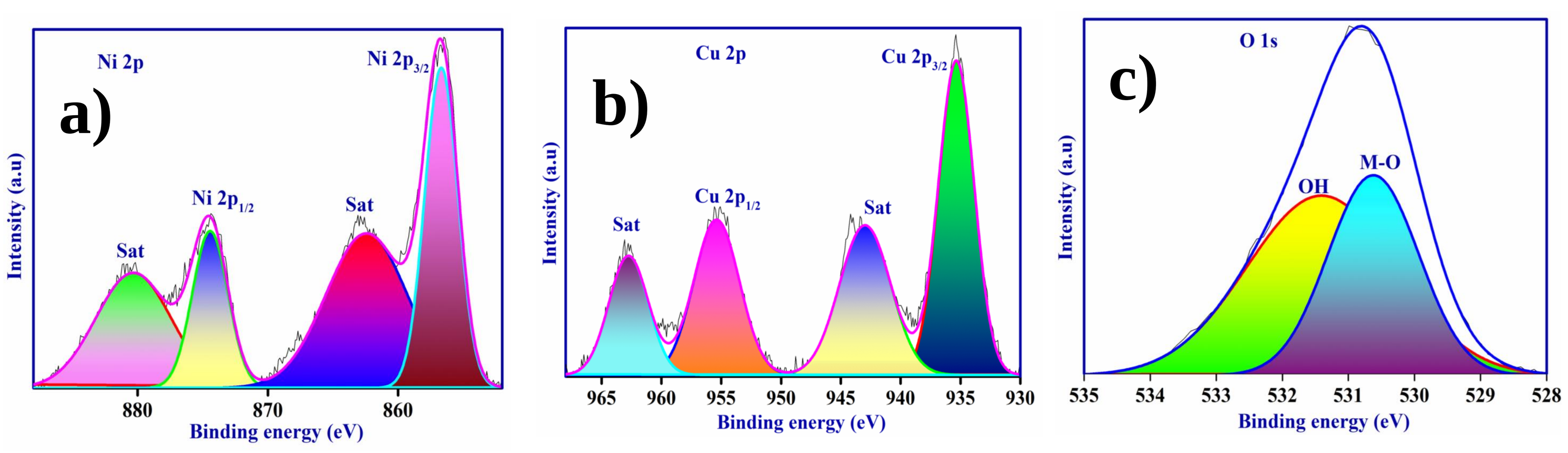


Fig.3 XPS spectra of a)Ni 2p, b) Cu 2p, c) O 1s

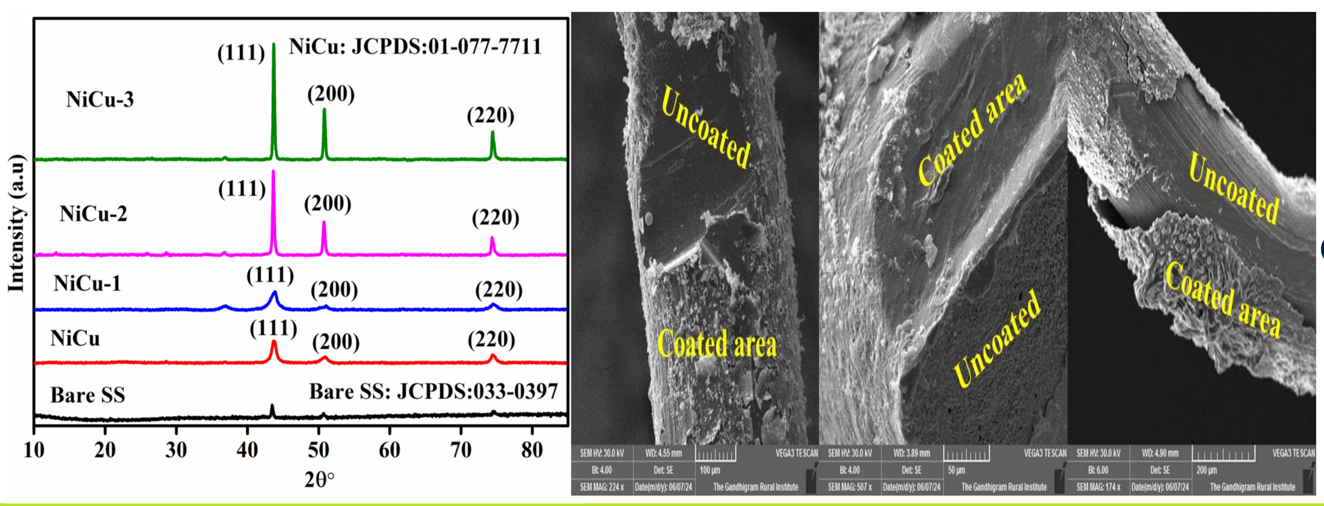


Fig.4. a) XRD spectra of NiCu@SS with various deposition times. b) Calculating the thickness of the coating.

Conclusions

- NiCu@SS was successfully synthesized by electrodeposition method using deep eutectic Solvents as electrolyte
- The deposition takes place uniformly and thickness of the coating was found to be 15 μm .
- Various techniques like XRD, EDX, and SEM are used to characterize the prepared catalysts
- The study revealed that the catalytic activity of NiCu@SS as a superior electrocatalyst in the water-splitting reaction
- NiCu@SS electrode shows excellent catalytic ability towards water-splitting with a cell voltage of 1.35 V
- The stability of NiCu@SS was tested by chronoamperometry technique up to 48h and 3000 cycle stability test

References

1. Edison, Thomas Nesakumar Jebakumar Immanuel, et al. " *Fuel* 297 (2021): 120786.
2. Maria Viyanni, Philominrajan, Thomas Nesakumar Jebakumar Immanuel Edison, and Mathur Gopalakrishnan Sethuraman. Materials Today Sustainability 24 (2023): 100565.

International Conference on
Composite Materials for Environment Protection & Remediation
(ICCMEPR - 2024) 02-03 July, 2023