Structural, morphological and electrochemical analysis of hydrothermally fabricated binary palladium alloys for use as efficient catalysts in DSSC counter electrodes

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Outline

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- Aims & Objectives
- Methodology
- Results
- References
- Acknowledgements

Background of study

- Greater demand for more energy necessitated by the rising world population and high economic development.[1]
- The need to limit the emission of toxic materials into the atmosphere
- Geopolitical instability causing fluctuation of oil prices
- Turn to renewable energy sources in order to fullfil the stringent environmental regulations enacted by various governments
- Potential alternatives include the DSSC technology which was invented by Michael Gratzel in 1991 mimicking the conversion of sunlight into energy by plants.[2]

Background of Study

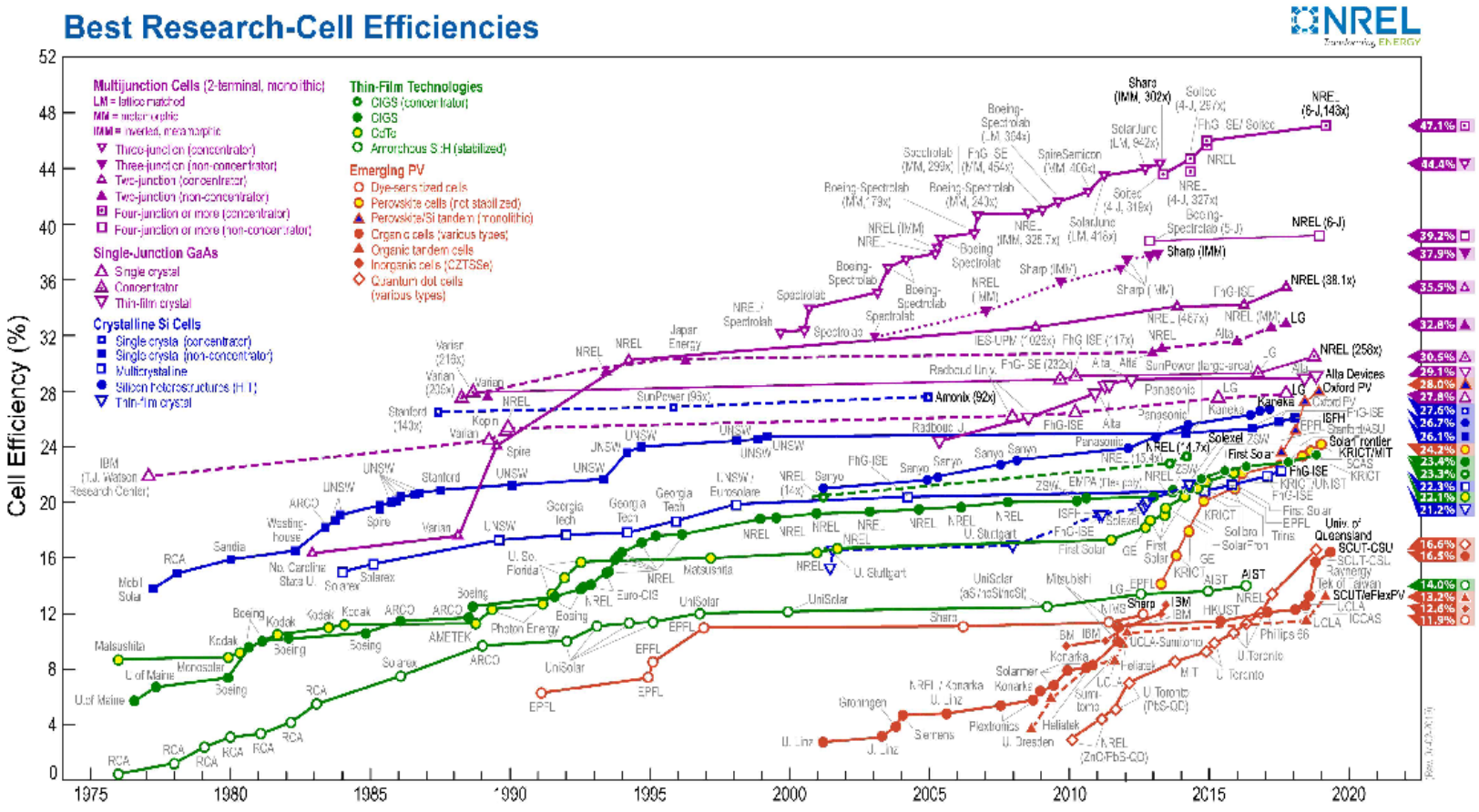


Figure 1. Illustration of cell efficiencies up to date

Background of Study

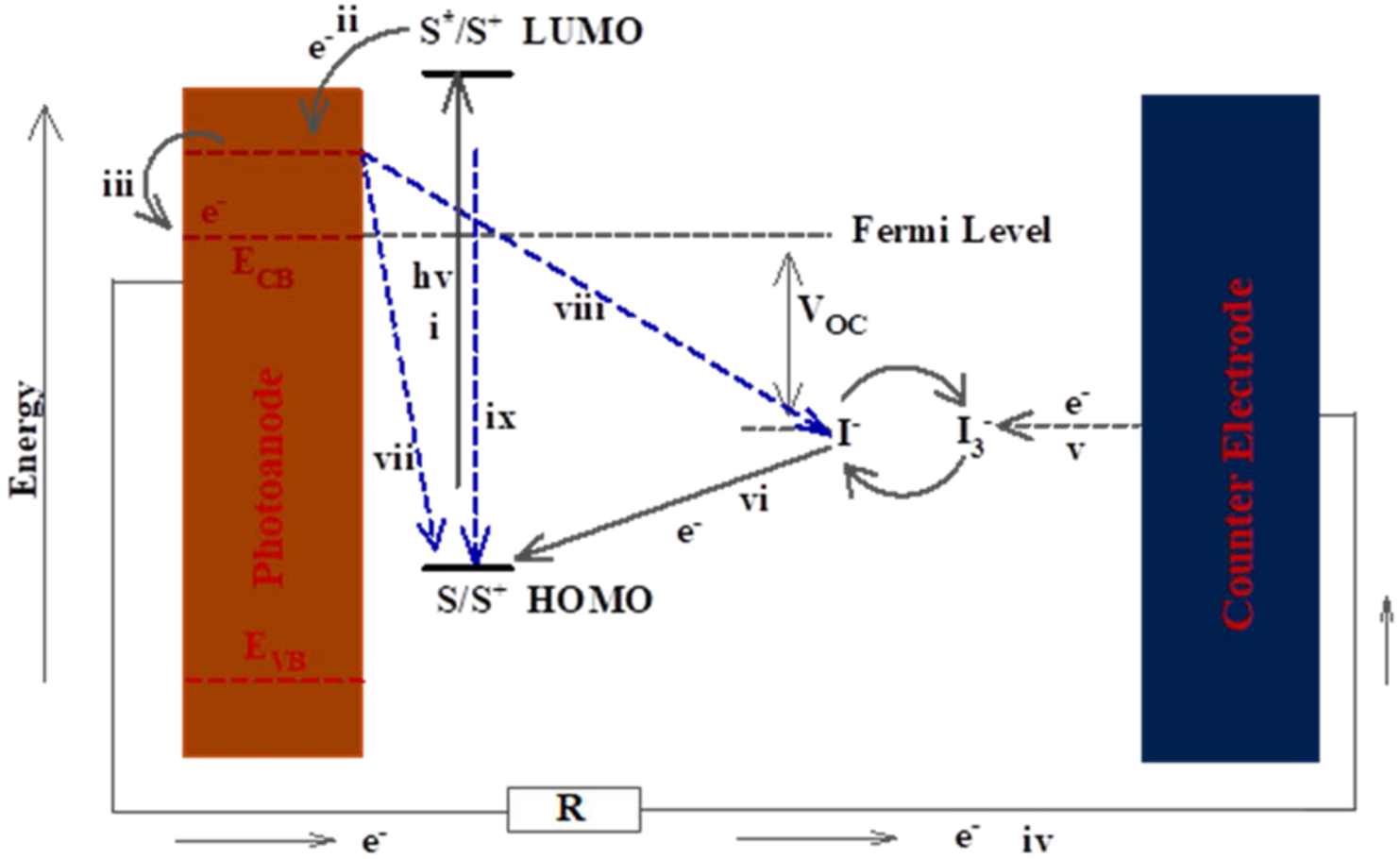
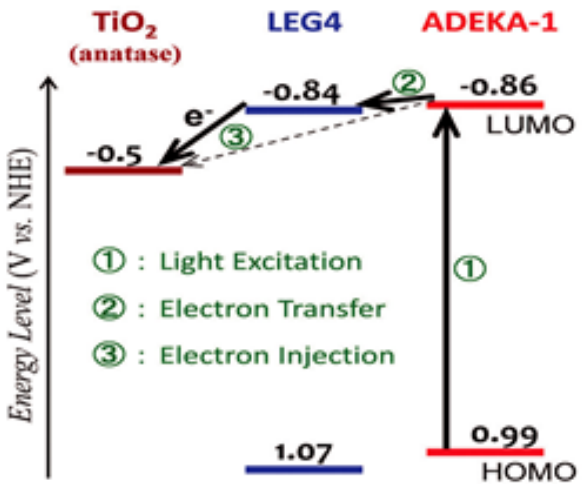
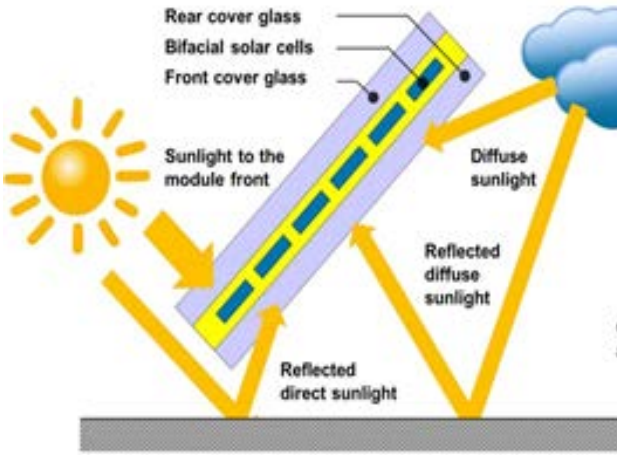


Figure 2. Operational procedure of a dye sensitized solar cell

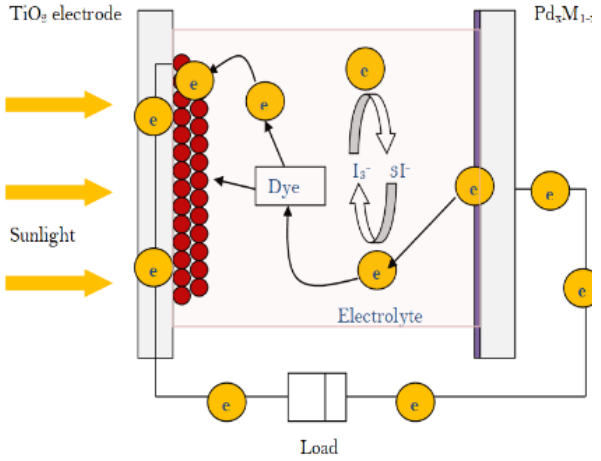
Possible solutions to the DSSC problems



(a)



(b)



(c)

Figure 3. illustration of possible solutions to solving the challenges facing the DSSC. Figures **4(a)** shows implementation of two different dye molecules by Kakiage and associates[3], **4(b)** implementation of bifacial solar cells, **4(c)** shows the current study which deals with the implementation of binary palladium alloys as well as iodine free electrolytes.

Aims and Objectives

Aim

- Develop binary palladium alloy CE PdNi and PdCo for DSSC use

Objectives

- To hydrothermally synthesize binary palladium alloys
- Determine the structure and morphology of the synthesized palladium alloys using XRD, SEM, and TEM respectively.
- Evaluate the electrochemical properties of the developed palladium counter electrode samples using CV, EIS and CD.
- Compare the performance of the developed palladium alloy samples to the platinum counter electrode. Comparison is conducted on the basis of the electrochemical data rather than the obtained photovoltaic parameters.

Synthesis procedure

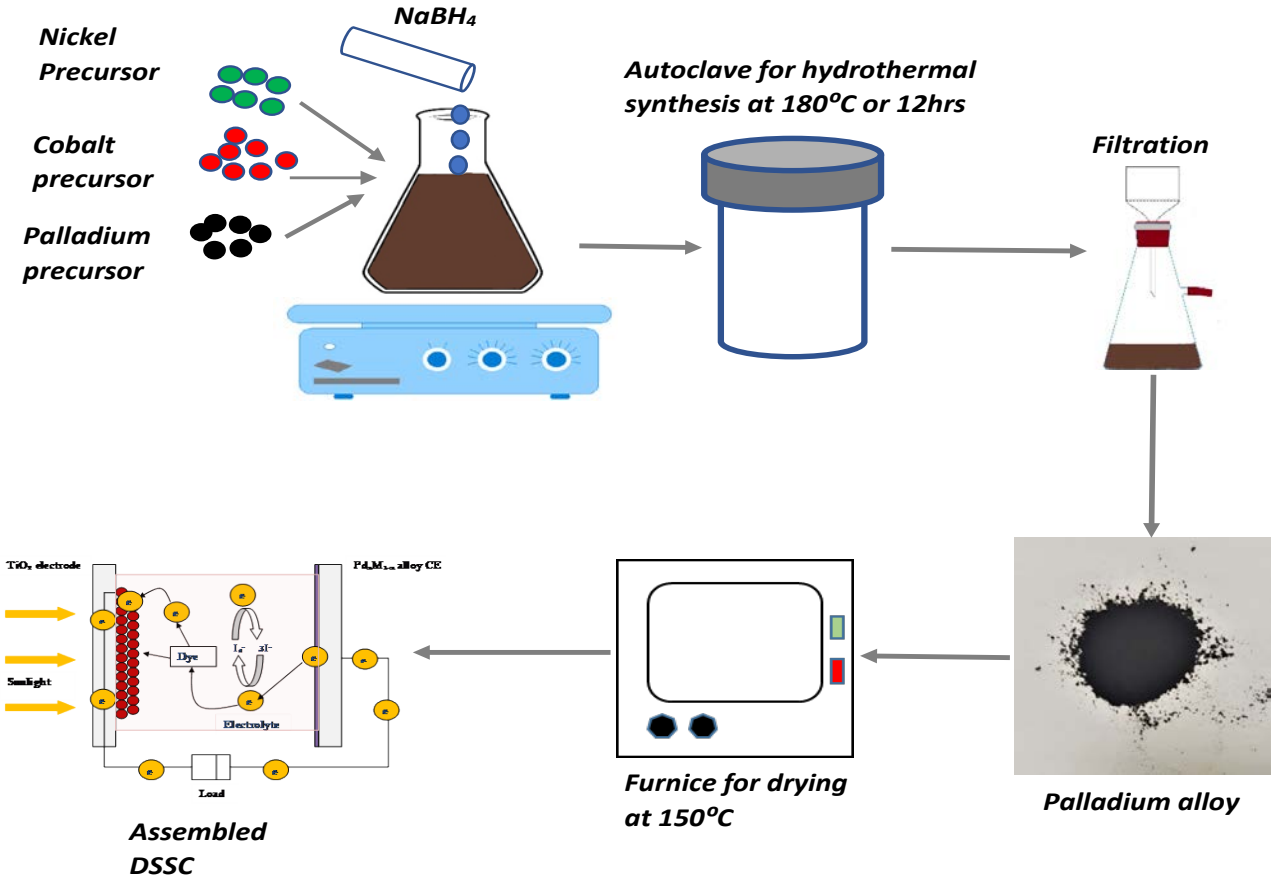


Figure 4. Synthesis procedure for the binary palladium alloys PdNi and PdCo

Results: XRD

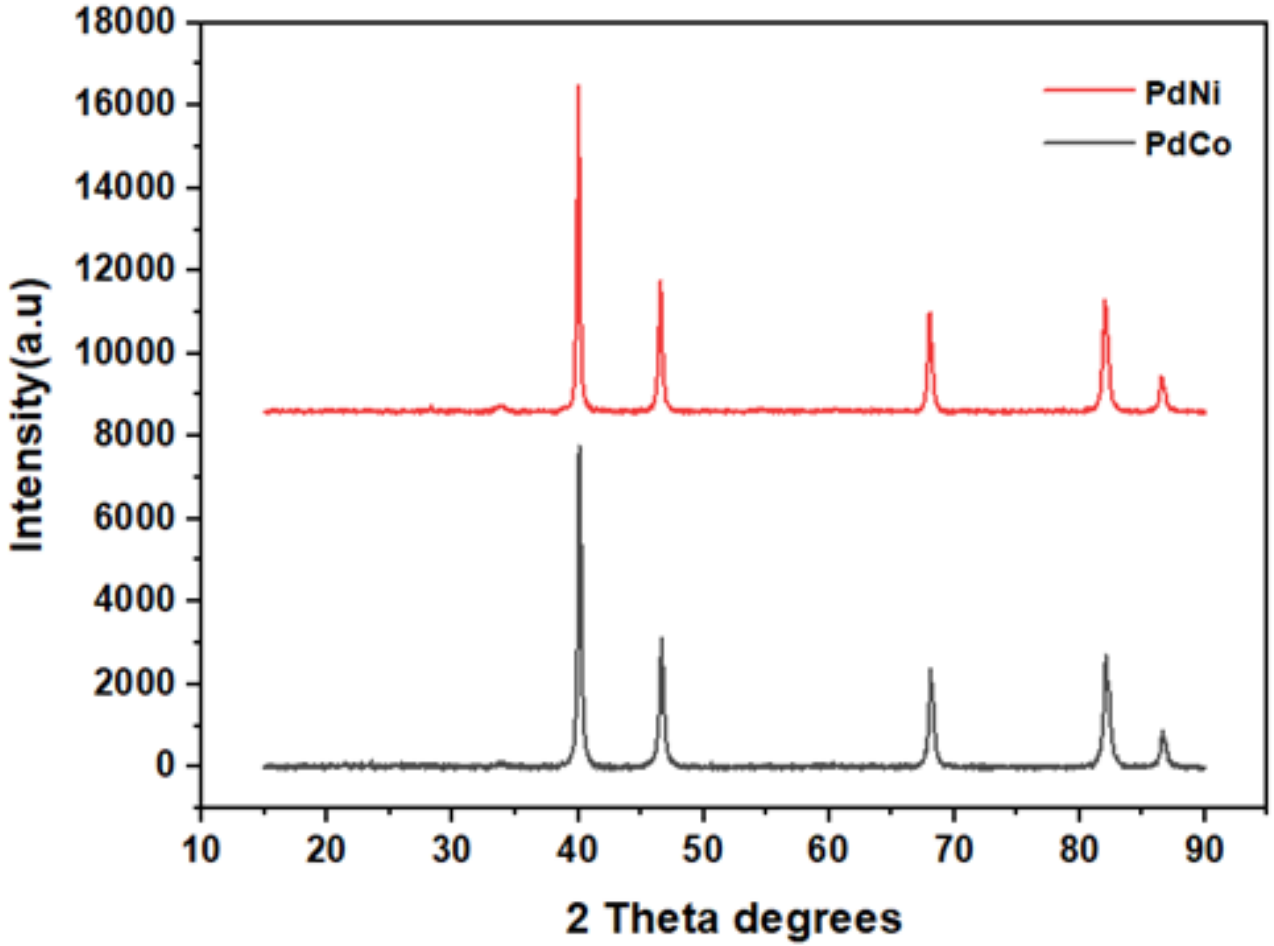
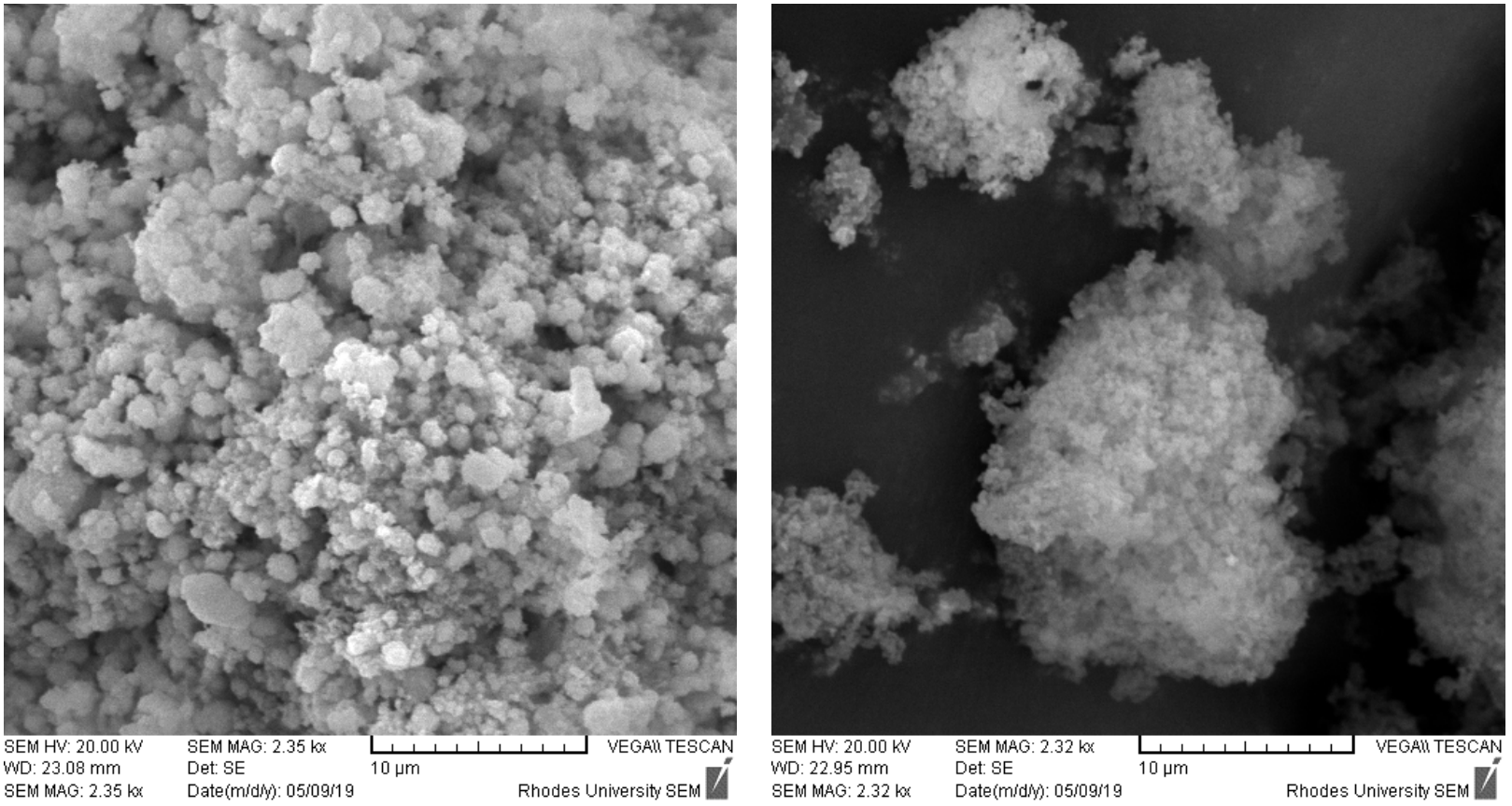


Figure 5. XRD images of binary palladium alloys PdNi and PdCo.

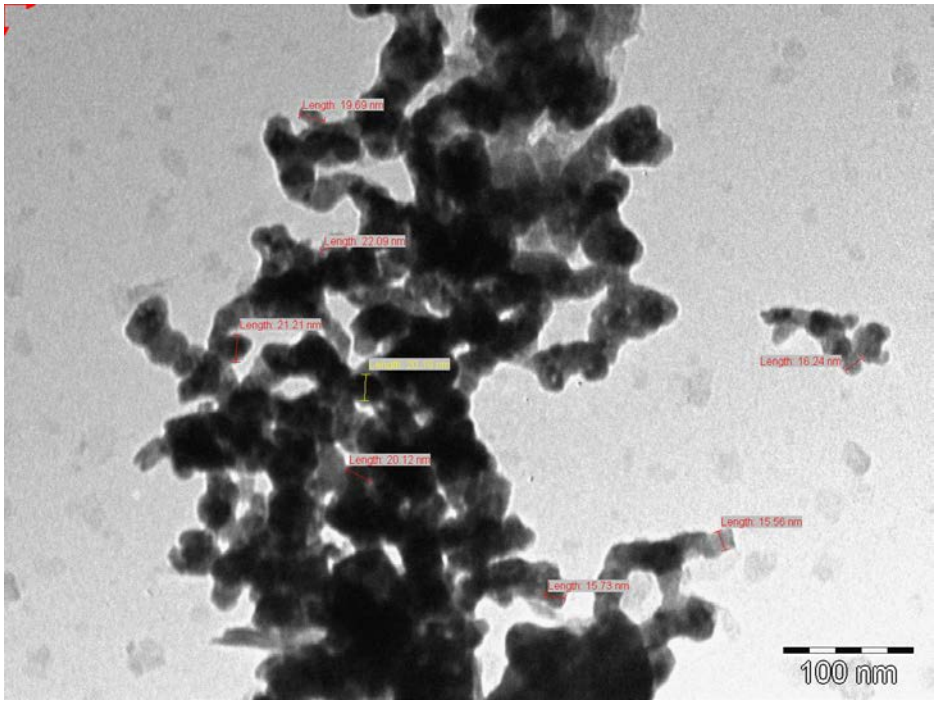
SEM ANALYSIS



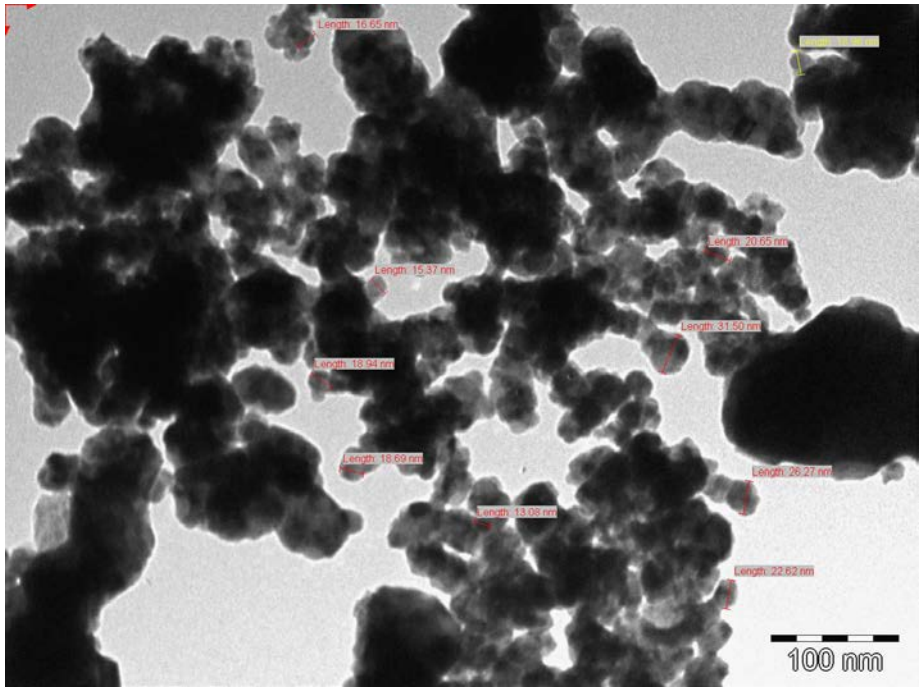
(a) (b)

Figure 6. SEM images for binary palladium alloys (a) **PdNi**, (b) **PdCo**

TEM Analysis



(a)



(b)

Figure 7. TEM images for the binary palladium alloys. (a) **PdCo** , (b) **PdNi**

Cyclic Voltammetry

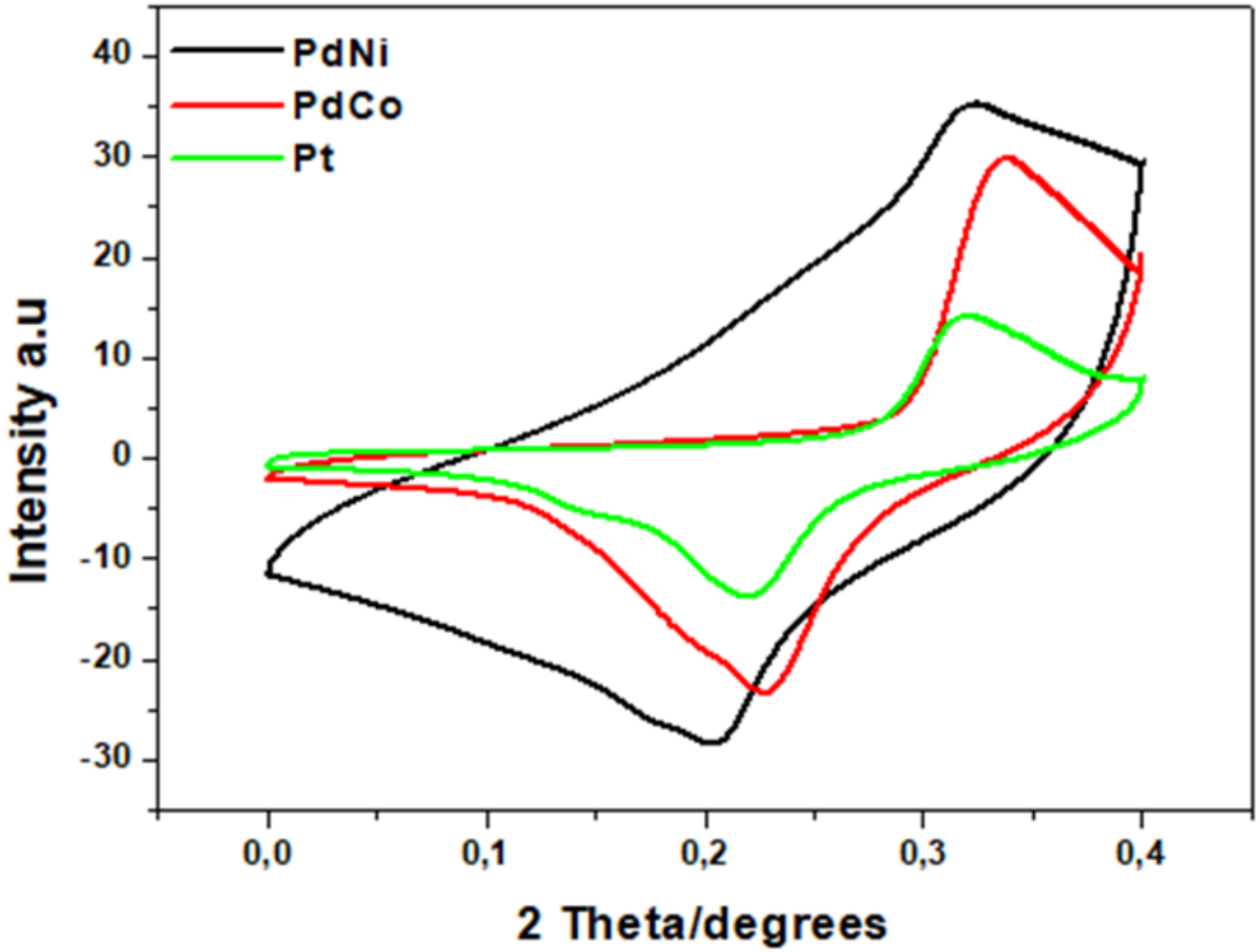


Figure 8. Cyclic Voltammetry curves for the binary palladium alloys

Electrochemical impedance analysis

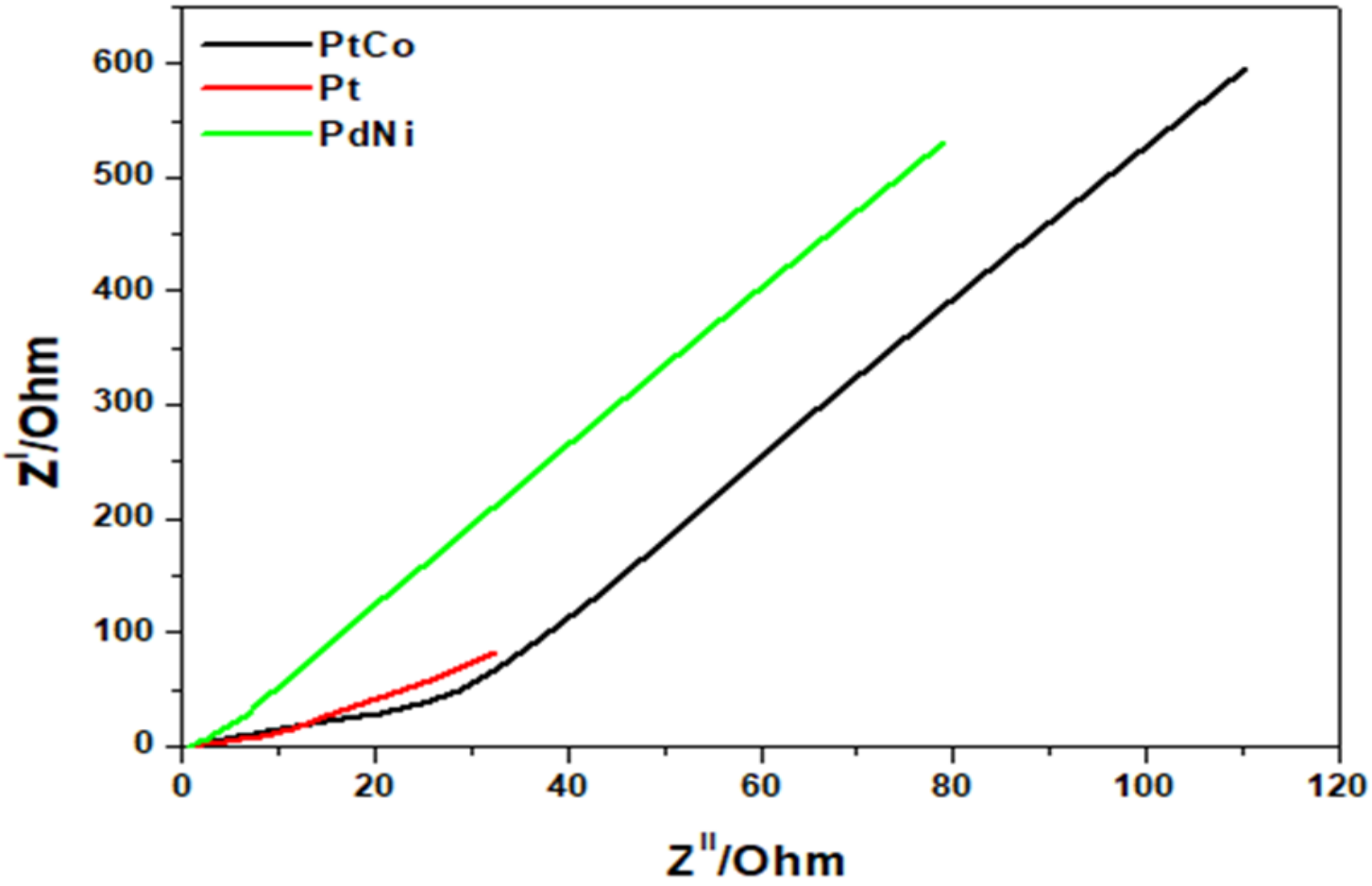


Figure 9. Electrochemical Impedance Spectroscopy graphs for the binary palladium alloys

Conclusion

- XRD has shown 5 dominant peaks at 2 theta values of 40°, 46.2°, 63.2,° 71.2°,75.1°,83.3° and 86.1° for PdCo and PdNi.
- SEM identified spherical densely packed PdCo particles whereas PdNi was composed of nanoneedles.
- CV results showed that PdNi had more reduction current density however it also possessed a higher peak to peak potential difference signifying a lower rate of reduction intensity.
- From EIS analysis PdNi possessed the least charge transfer resistance at 0.2052ohm with PdCo and Pt producing 0.21223 and 0.20626 ohm respectively
- Obtained results show that palladium alloys could potentially replace platinum in DSSC counter electrodes.

References

1. N. Ali, A Hussain, A Ahmed, R Wang, MK Zhao. Renew. Sust.Energy.Rev.59(2016) 726-737

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3. K Kakiage, Y Aoyama, T Yano, K Oya, J Fujisawa, M Hanaya. Highly efficient dye sensitized solar cells with collaborative sensitization by silyl-anchor and carboxyl-anchor dyes.

4. S.Yun, N Vlachopoulos, A Qurashi, S Ahmad, A Hagfeldt. Dye sensitized photoelectrolysis cells.

Thank you for your attention !

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