Unique Nanocatalysts for Fuel Cells by Photocatalytic Deposition

STUDENTS / UNIVERSITIES

Zahide Tuğba Sarı – Sabancı University
Siddhartha Peri – University of Illinois Urbana-Champaign
Emre Utku Öztürk – Sabancı University

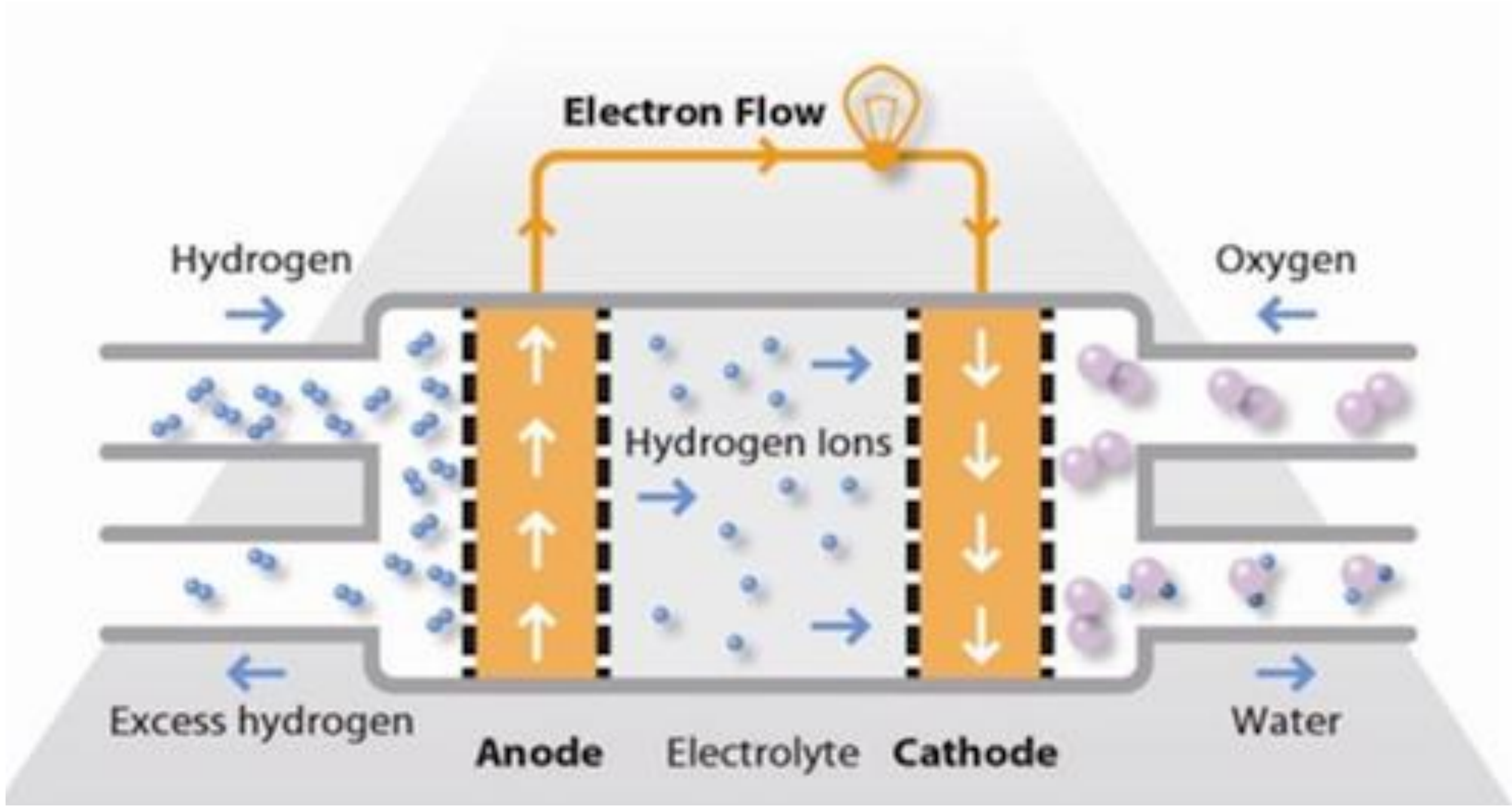
SUPERVISOR(S)

Selmiye Alkan Gürsel
Alp Yürüm
Navid Haghmoradi

Sabancı Üniversitesi

PURE PROGRAM FOR UNDERGRADUATE RESEARCH

Introduction



Polymer Electrolyte Membrane Fuel Cells (PEMFC shown above) are a promising new technology that can be utilized to power automotive vehicles while having the advantage of being carbon neutral. Fuel cells contain an oxygen reaction and a hydrogen reaction, but since oxygen and hydrogen are gases, they require a substance like platinum to act like a bedrock layer and adsorb onto, increasing the kinetic activity of the fuel cell. The purpose of this research is to develop a synthesis method for kinetically-efficient and durable Pt nanoparticles with the help of graphene derivatives and UV light.

Components and Technical Background

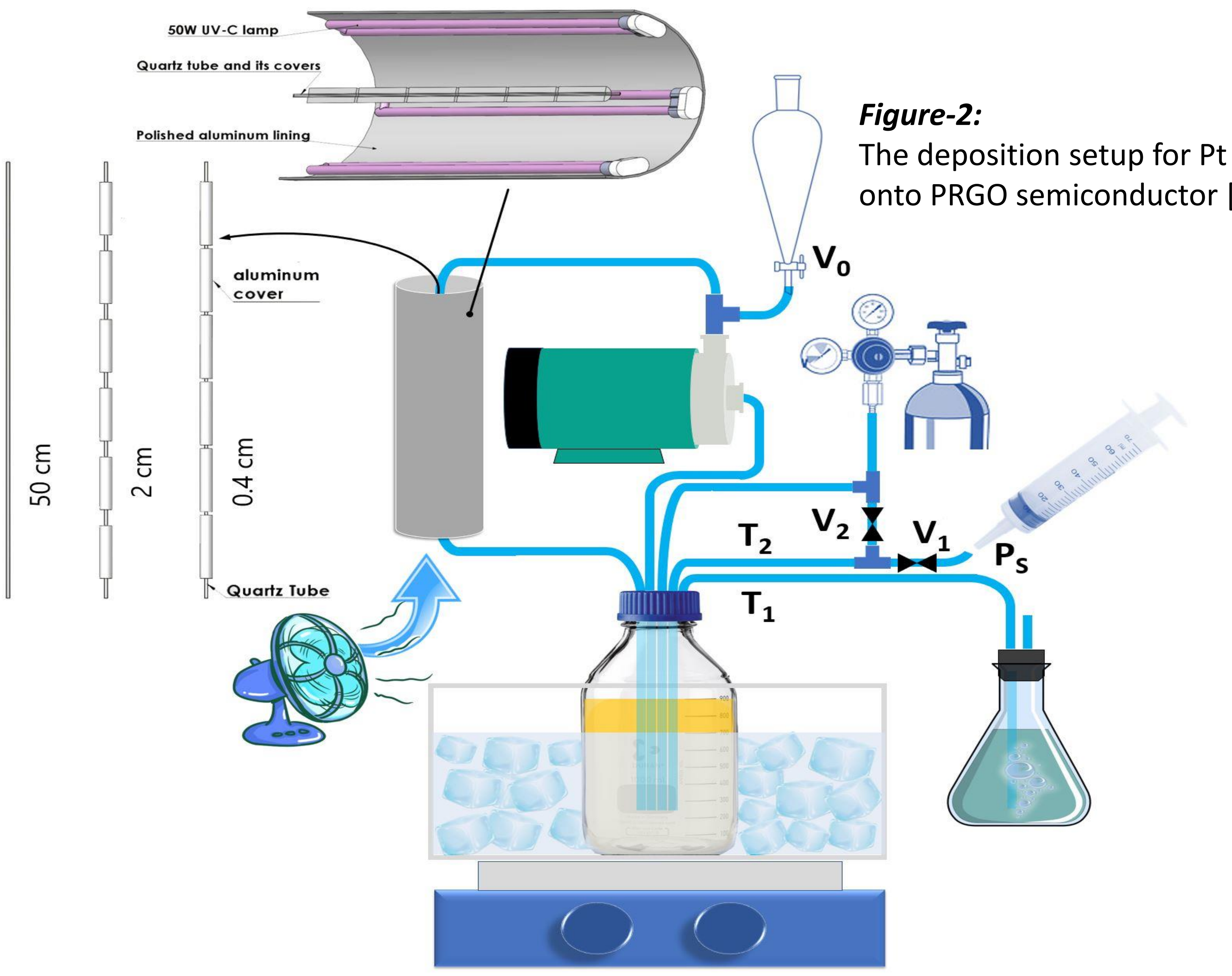
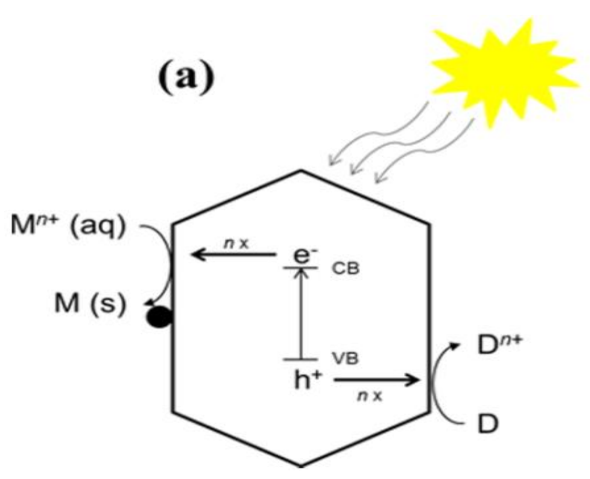


Figure-2: The deposition setup for Pt onto PRGO semiconductor [1].



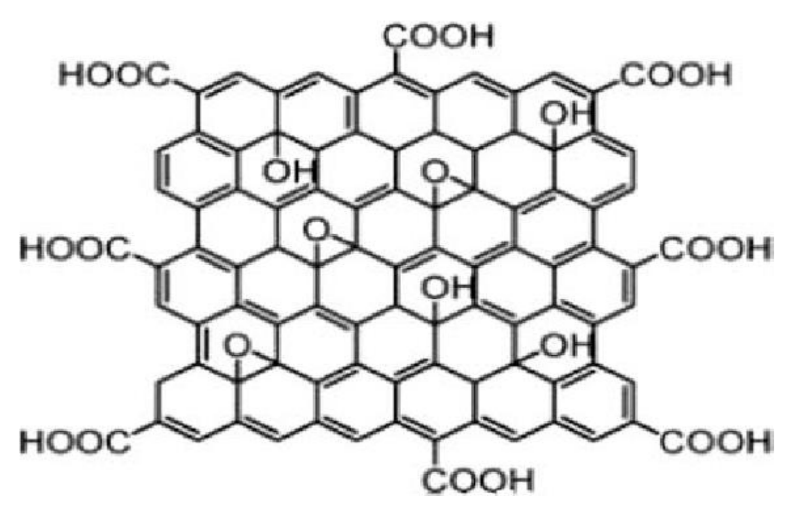


Figure- 3: The band gap of PRGO semiconductor that the electron in the valence band migrates to the conduction band with UV light exposes the PRGO.

Figure-4: Structure of graphene oxide. PRGO and RGO contain fewer oxygen functional groups [3].

Experimental

1. Pt precursor (H_2PtCl_6) and methanol (CH_3OH) were mixed with partially reduced graphene oxide (PRGO) under the above setup and underwent UV exposure under different intensities (100% exposure vs. 20% exposure).
2. After synthesis, Pt/PRGO compound underwent 2.5 hours of reduction using ascorbic acid for further removing the functional groups and Pt/RGO was synthesized as a final sample.

Results and Discussion

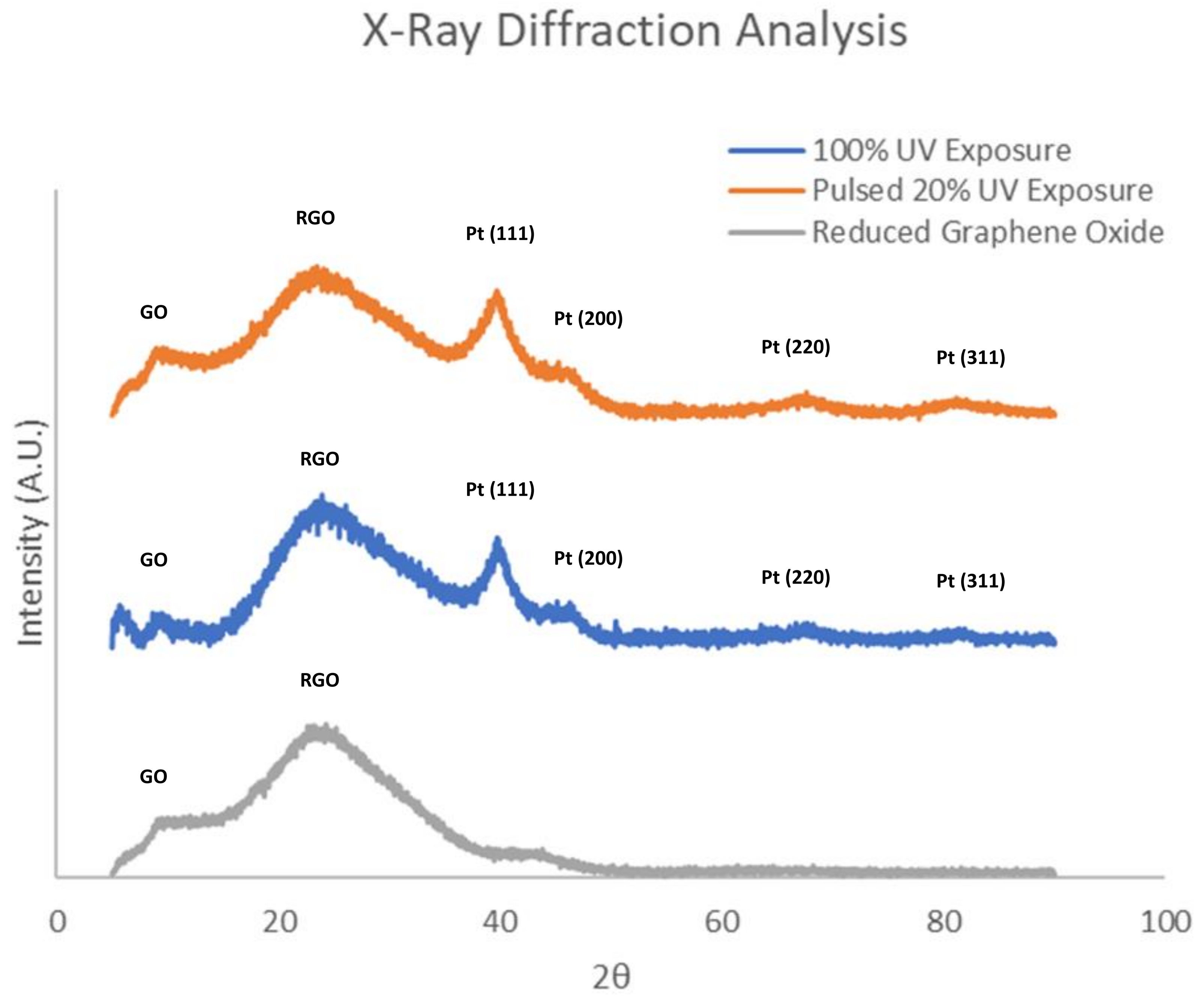
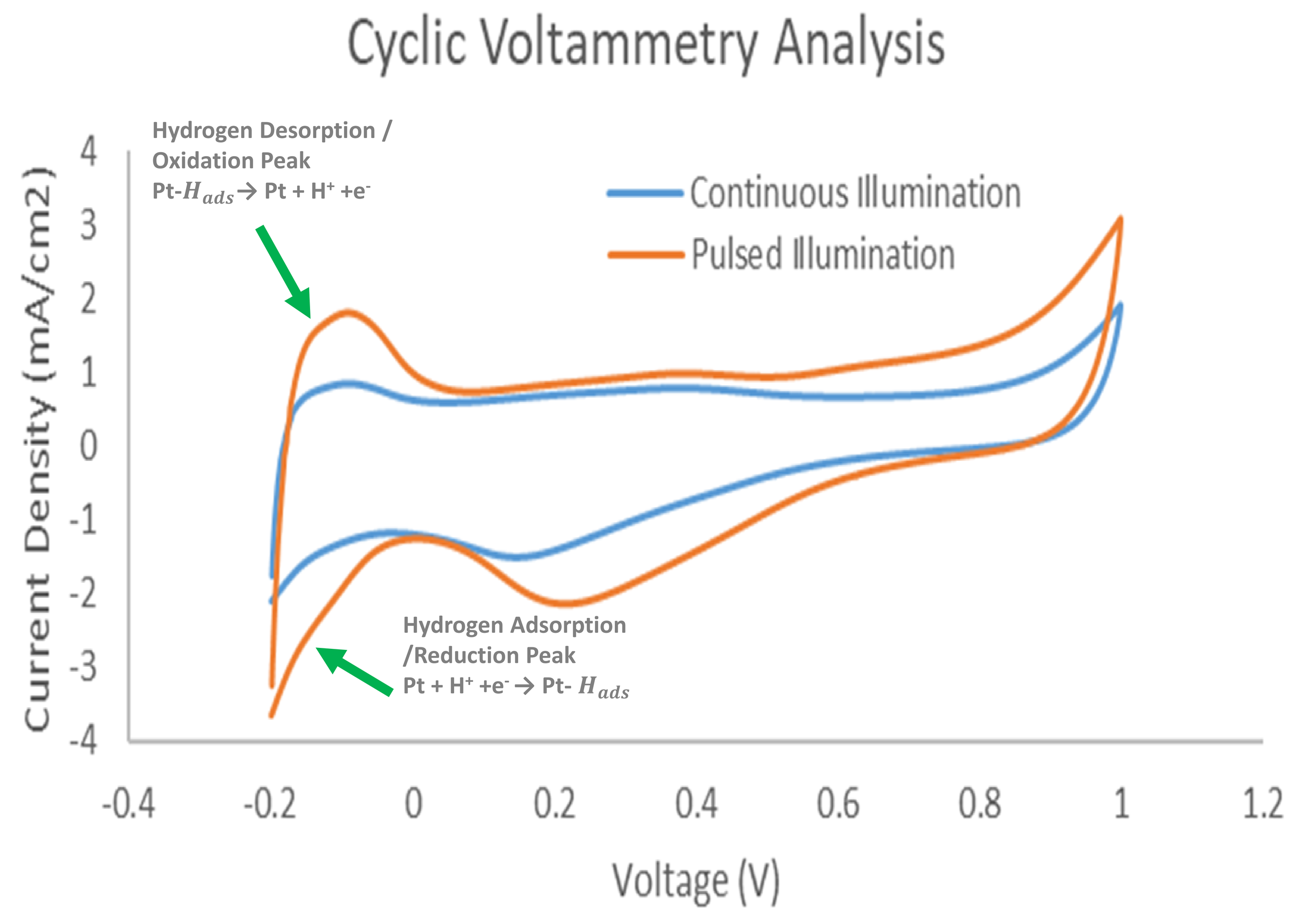
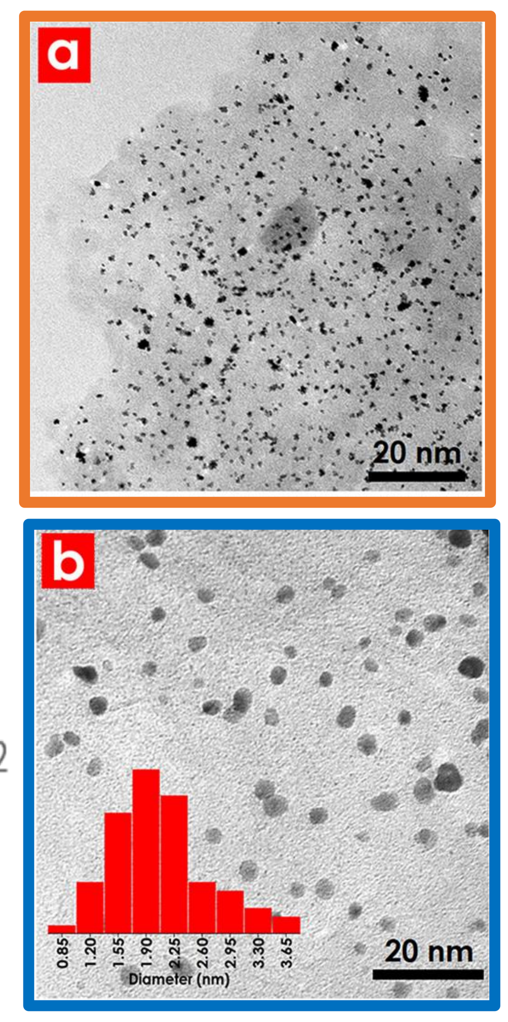


Figure-5: Compared with the control XRD of pure reduced graphene oxide (RGO) with no Pt present, the XRD graphs of continuous UV exposure and of pulsed 20% UV exposure show comparably high Pt (111) loading onto the rGO.





[1]

Figure-6: The cyclic voltammetry analysis results showed that pulsed illumination of Pt on PRGO produces higher electrochemical activity than that of continuous illumination of Pt on PRGO.

Conclusions

- Pulsed Pt nanoparticles showed higher electrochemical activity than that of 100% UV exposure.
- In the future, further research on bimetallic nanoparticles such as a Pt-Au will be explored to increase electrochemical activity and decrease the cost of the nanocatalyst.

References

[1] Sina Abdolhosseinzadeh, Sina Sadighikia, Selmiye Alkan Gürsel, ACS Sustainable Chemistry and Engineering, 6(2018) 3773-3782.

[2] Sina Abdolhosseinzadeh, Mirsajjad Mousavi, Navid Haghmoradi, Selmiye Alkan Gürsel, A Continuous-flow Photocatalytic Reactor for the Precisely Controlled Deposition of Metallic Nanoparticles. *J. Vis. Exp.*, e58883, (2019).

[3] Kobra Gerani, Hamid Mortaheb, Babak Mokhtarani, Preperation and characterization of sulfonated polyether sulfone composite ion-exchange membranes filled by graphene oxide Nano sheets. *Taylor & Francis Group*, (2015).