



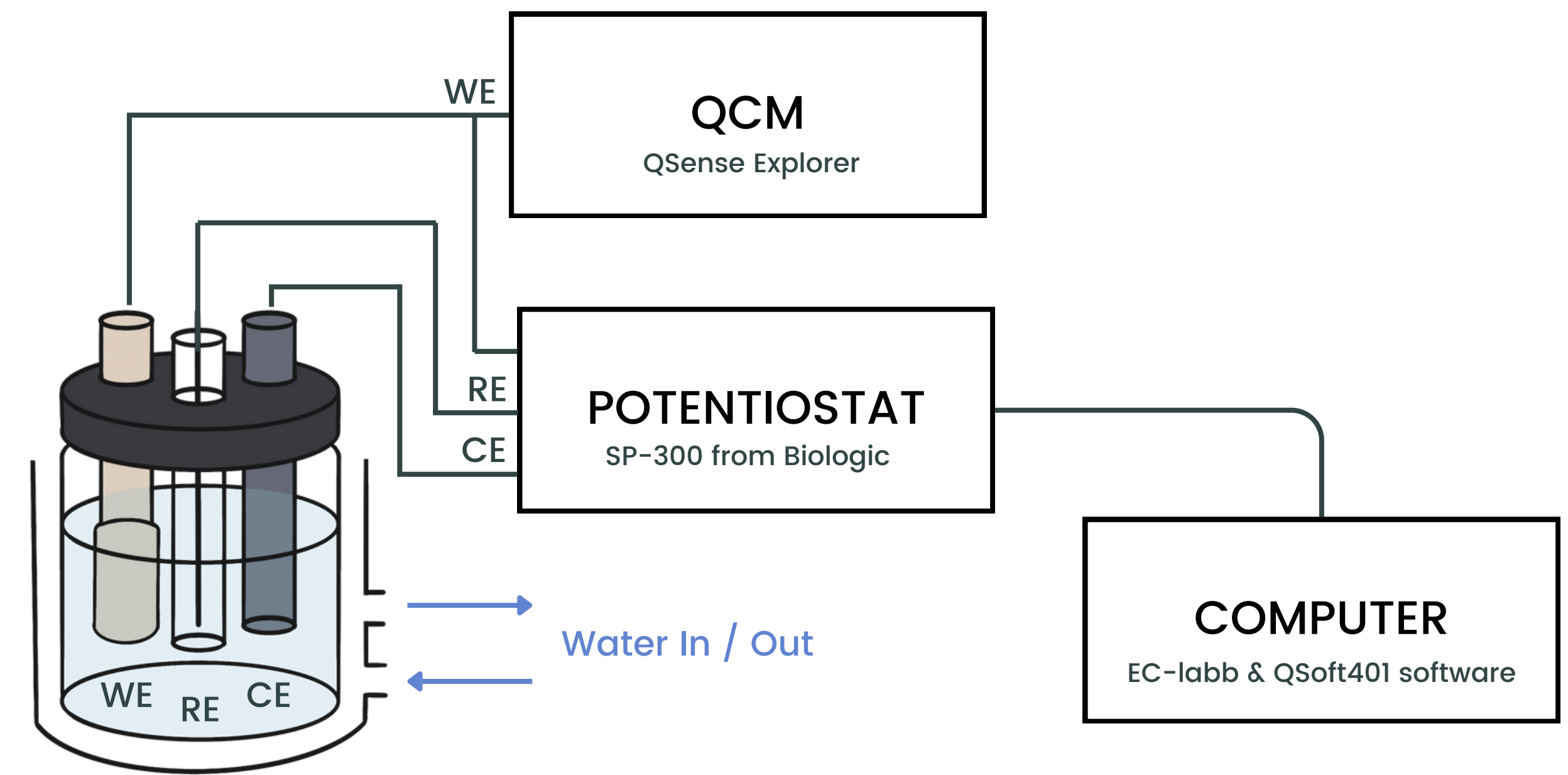
## INTRODUCTION

The global trend towards decarbonization is driving interest in proton-exchange membrane fuel cells (PEMFCs) as a promising alternative to fossil fuel engines. PEMFCs offer high efficiency in converting hydrogen's energy into electricity without CO<sub>2</sub> emissions. However, the dissolution of platinum (Pt), which is often used as a commercial catalyst, is one of the primary mechanisms of fuel cell catalyst degradation. This occurs when Pt oxide is reduced during the operation, leading to Pt dissolution into an electrolyte. [1][2]

This results in a loss of surface area and decreased electrochemical activity, which impact the lifetime of fuel cell components.[3]

## SCOPE

This project aims to investigate the mass loss of the Pt catalyst during electrochemical processes under different operating voltages ranging from 0.8 to 1.4 V by using the electrochemical method coupled with a quartz crystal microbalance as a mass sensor.



WE: Working Electrode RE: Reference Electrode CE: Counter Electrode  
EQCM Experimental Setup

## METHODOLOGY



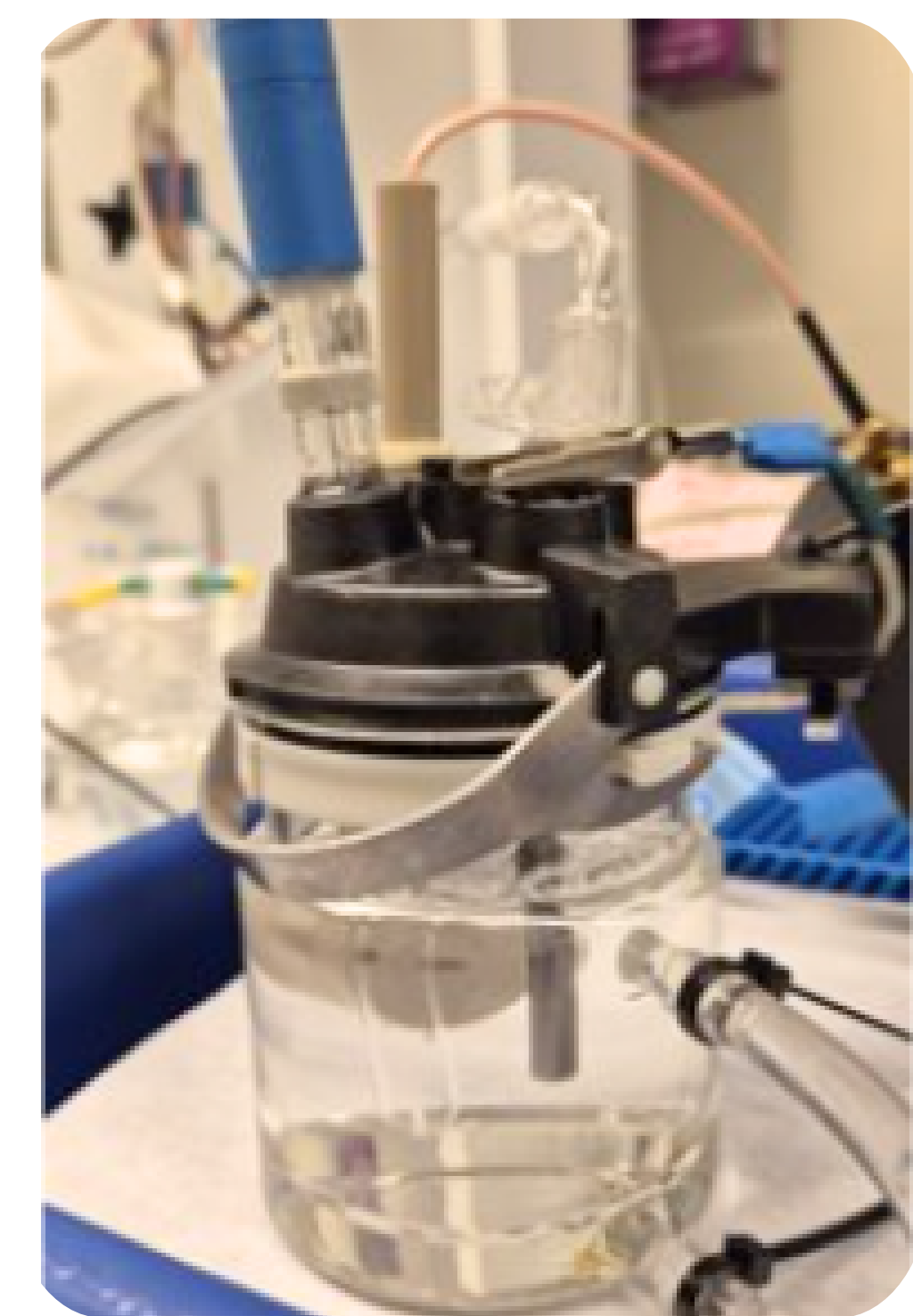
USE CRYSTAL WITH  
A 3NM TITANIUM UNDERLAYER  
AND A 200NM PLATINUM LAYER  
ON TOP



USE GRAPHITE ELECTRODE AS A  
COUNTER ELECTRODE



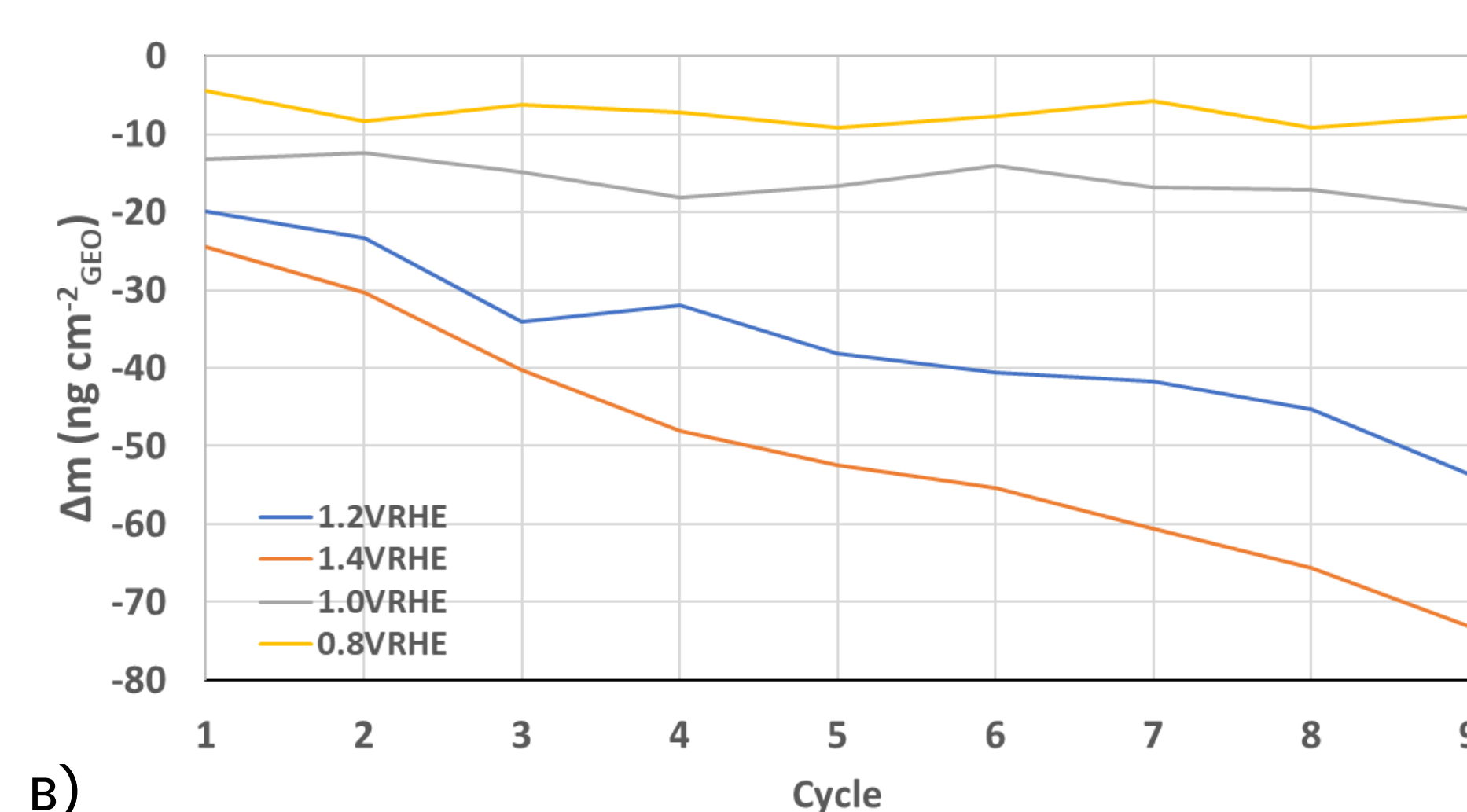
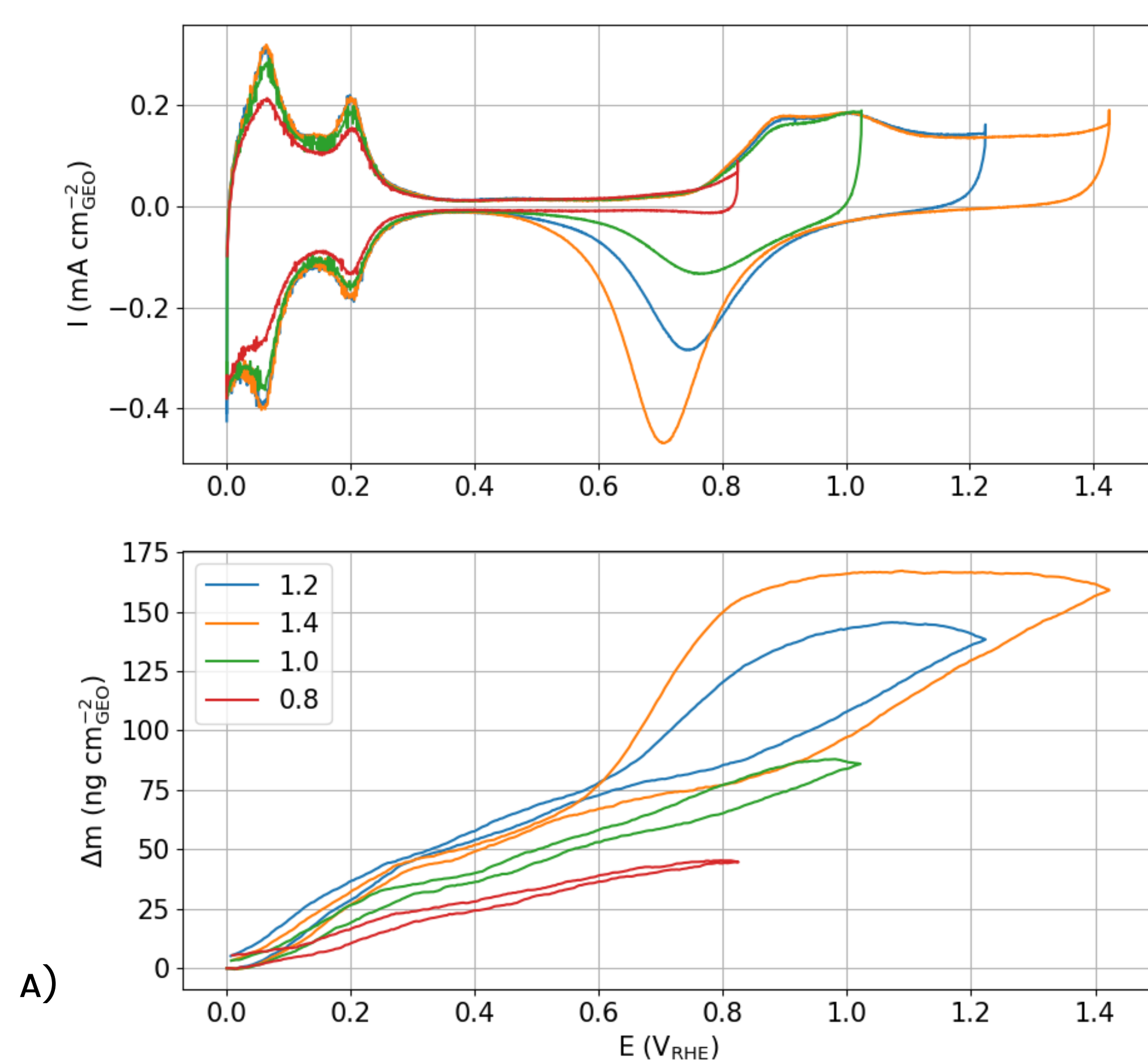
USE MERCURY-MERCUROUS  
SULFATE ELECTRODE (HG/HG<sub>2</sub>SO<sub>4</sub>)  
AS A REFERENCE ELECTRODE



USE 0.5M SULFURIC ACID (H<sub>2</sub>SO<sub>4</sub>)  
AS ELECTROLYTE  
PURGE WITH ARGON TO CREATE  
AN OXYGEN-FREE ENVIRONMENT

## RESULTS

The Cyclic Voltammetry's (CVs) measured in 0.5 M H<sub>2</sub>SO<sub>4</sub> show the characteristic features of a pure poly crystalline Pt surface and the corresponding mass response for different (Upper Potential Limits)UPLs as in figure A. During these electrochemical measurements, the frequency change of the crystal was measured using QCM for different overtones. The frequency shift is converted to mass shift using equation 1 and the amount of mass loss increases with UPL as in figure B and the average mass lost per cycle is as mentioned in the table.



$$\Delta m = -\Delta f \frac{\sqrt{\rho_q \mu_q}}{2\pi f_0^2} \quad (1)$$

UPL	Average Mass loss per cycle
1.4VRHE	-12,15
1.2VRHE	-8,4
1.0VRHE	-1,6
0.8VRHE	-0,825

### RELATED LITERATURE

- [1] G. Jerkiewicz, G. Vatankhah, J. Lessard, M. P. Soriaga, Yeon-Su Park, *Electrochimica Acta*, 49 (2004), 1451-1459.  
[2] S. Cherevko, N. Kulyk, Karl J.J. Mayrhofer. *Nano Energy*, 29 (2016), 275-298.  
[3] L. Strandberg, V. Shokhen, M. Luneau, G. Lindbergh, C. Lagergren, B. Wickman, *ChemElectroChem* (2022), 9, e202200591.

## CONCLUSION

Observed an increase in the mass loss with the upper potential limits, at an UPL of 0.8 VRHE, nearly no mass is lost between cycles and at an UPL of 1.4V some decent amount of mass loss occurred, which can be due to the Pt oxide layer formation is more at high UPL and more Pt is dissolved into the electrolyte when reduced rather than recrystallizing on the surface. Our results deliver a fundamental understanding of the electrochemical behavior of the fuel cell catalyst, when operated at different potentials.