Supporting information for

Tuning the electronic structure of PtRu bimetallic nanoparticles for promoting hydrogen oxidation reaction in alkaline media

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Supplementary Content

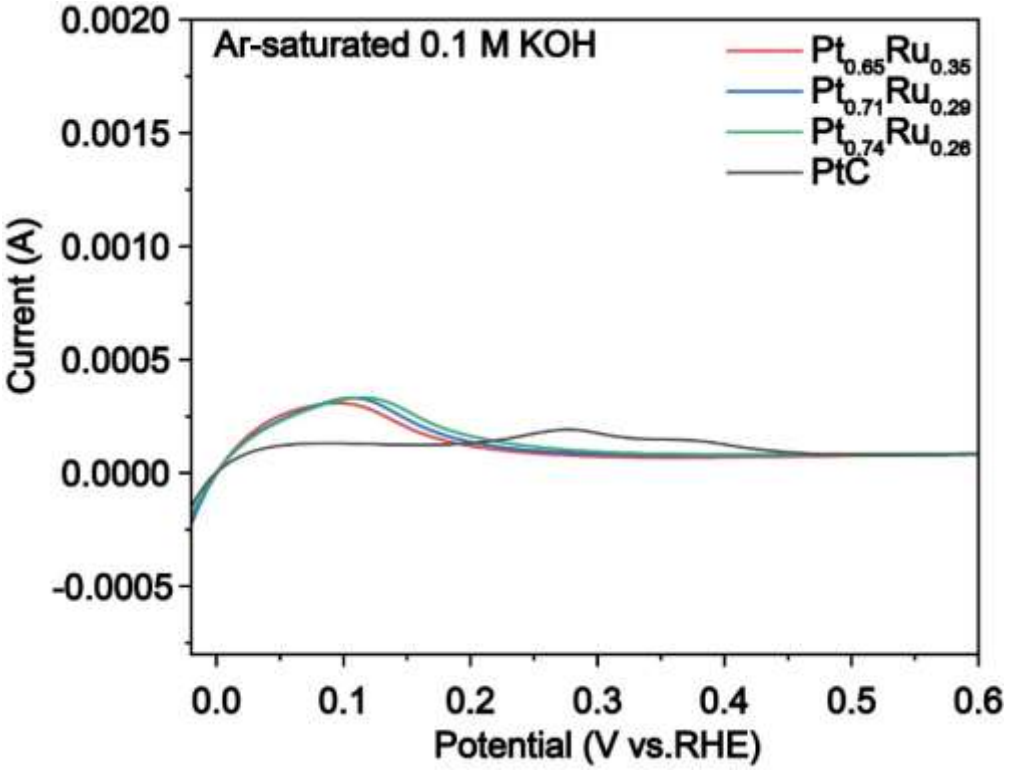

Figure S1. Polarization curves of PtRu bimetallic nanoparticles, and Pt/C in Ar-saturated 0.1 M KOH at a scan rate of 5 mV s^{-1} under rotating speed of 1600 r.p.m.

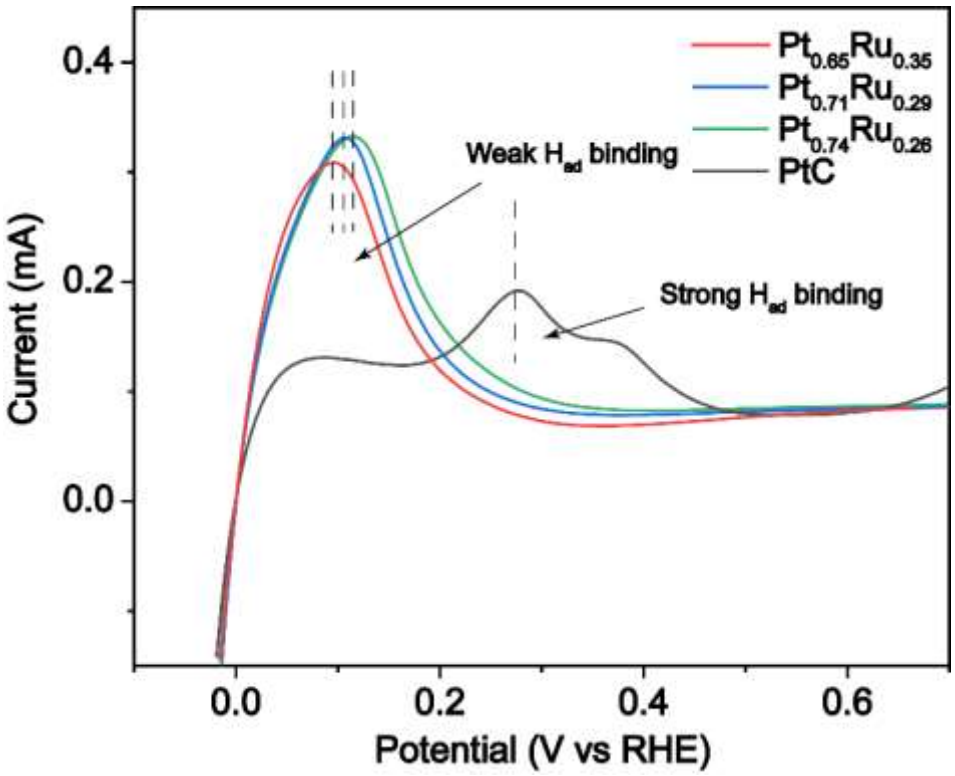

Figure S2. The impact of alloy degree on the Pt-H_{ad} interaction determined by electrochemical behavior of as-prepared catalysts in degassed 0.1 M KOH solution.

As displayed in **Figure S2**, the negative shift of oxidation peak of H_{ad} has been observed and this result indicates that the hydrogen-binding strength can be weakened according to the increased alloy degree.

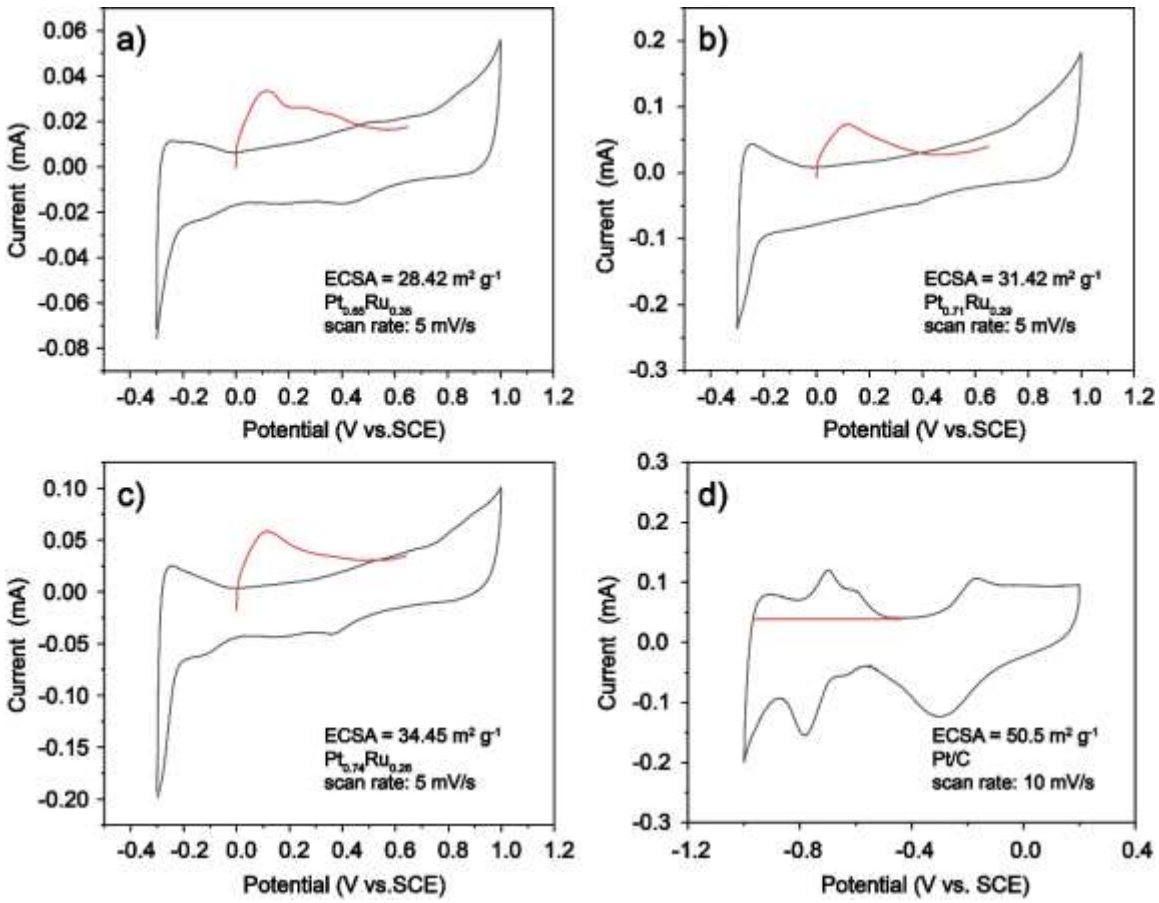

Figure S3. Electrochemical surface area measurements. a-c) Cu stripping on PtRu bimetallic nanoparticles for determining the specific surface area of Pt. d) H adsorption on Pt/C for determining the specific surface area of Pt.

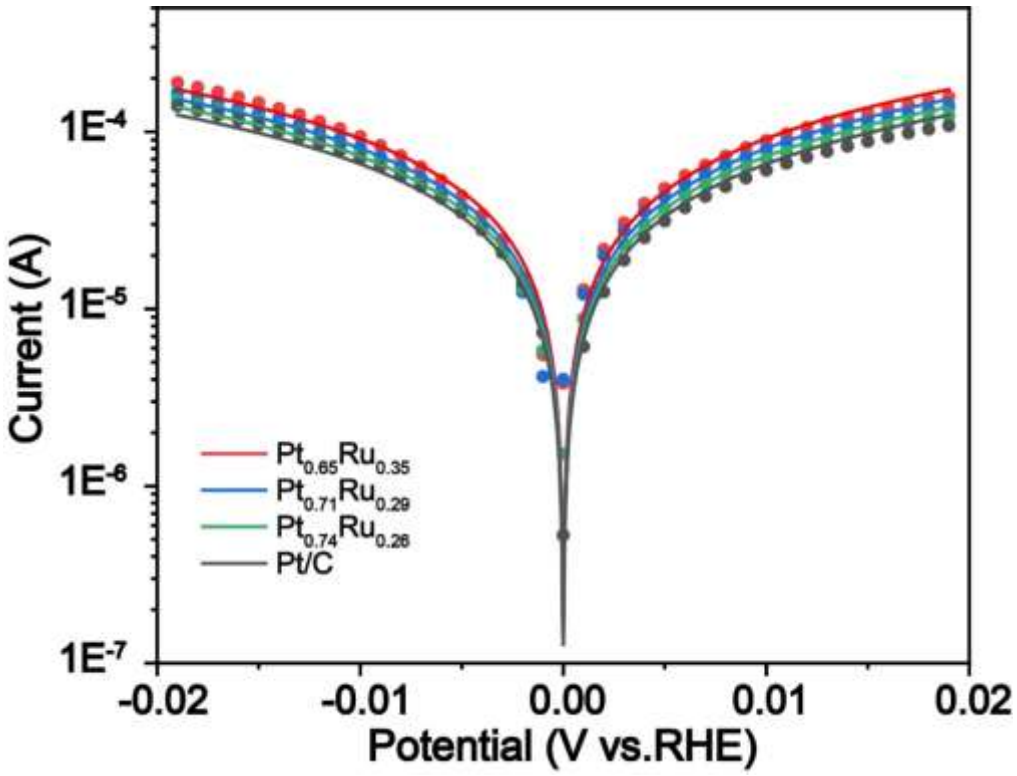

Figure S4. Tafel plots of PtRu bimetallic nanoparticles and Pt/C.

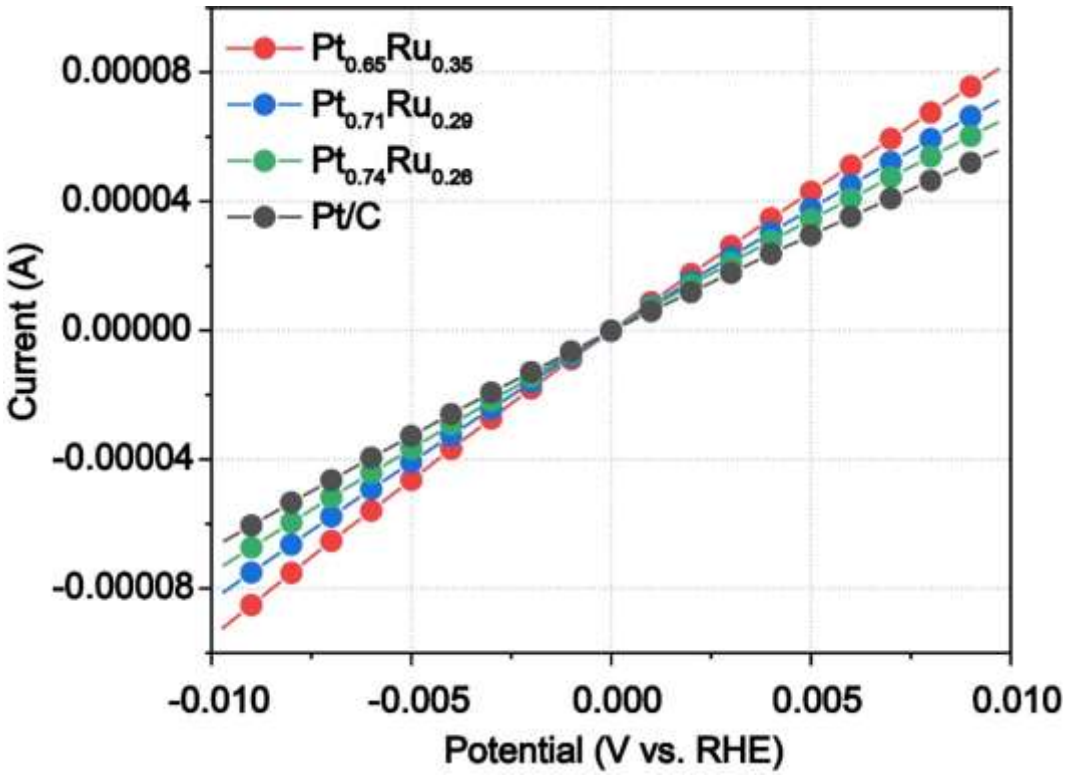

Figure S5. Micro-kinetic polarization plots of PtRu bimetallic nanoparticles and Pt/C.

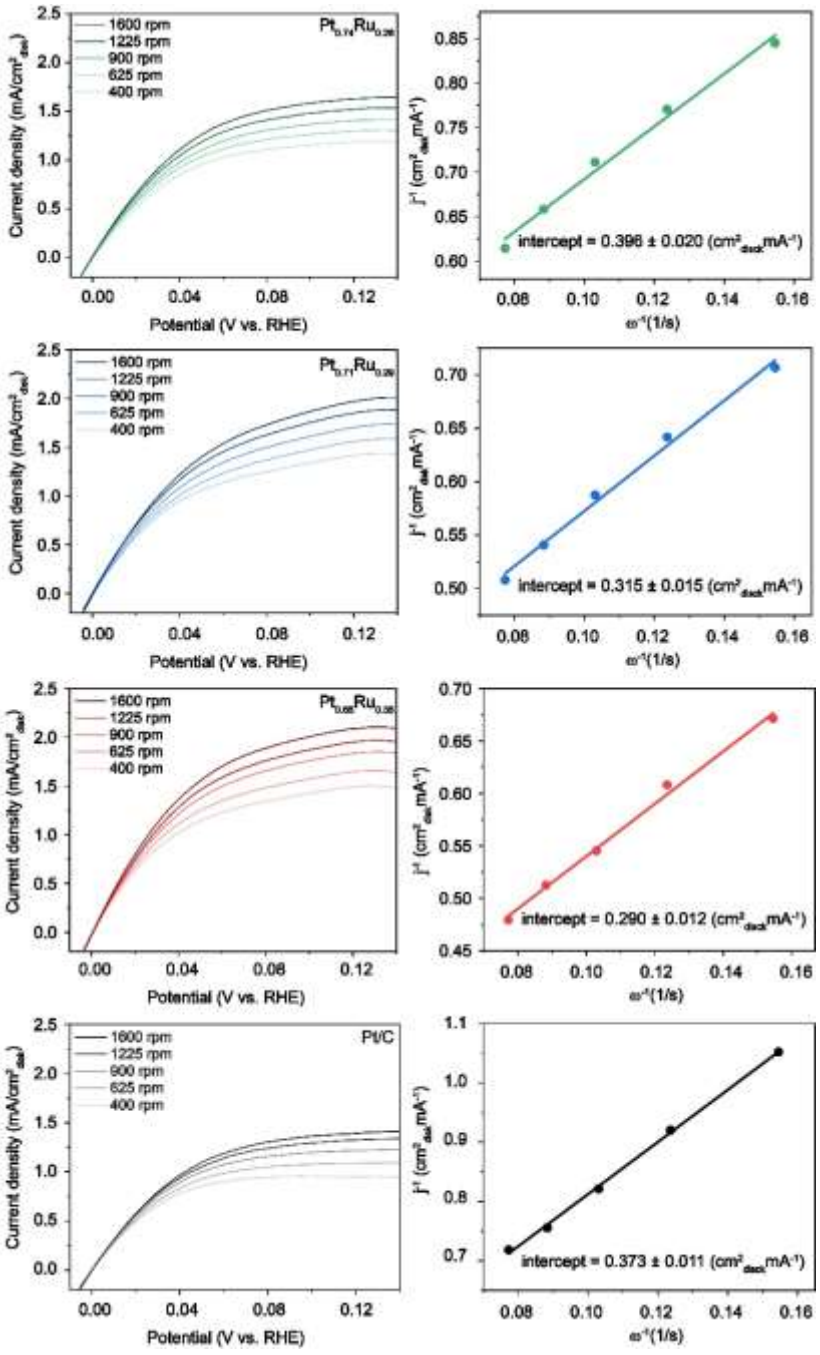

Figure S6. Polarization curves of PtRu bimetallic nanoparticles and Pt/C in H_2-saturated 0.1M KOH at a scan rate of 5mV/s at various rotating speeds. The followed is the corresponding Koutecky–Levich plots at an overpotential of 120mV.

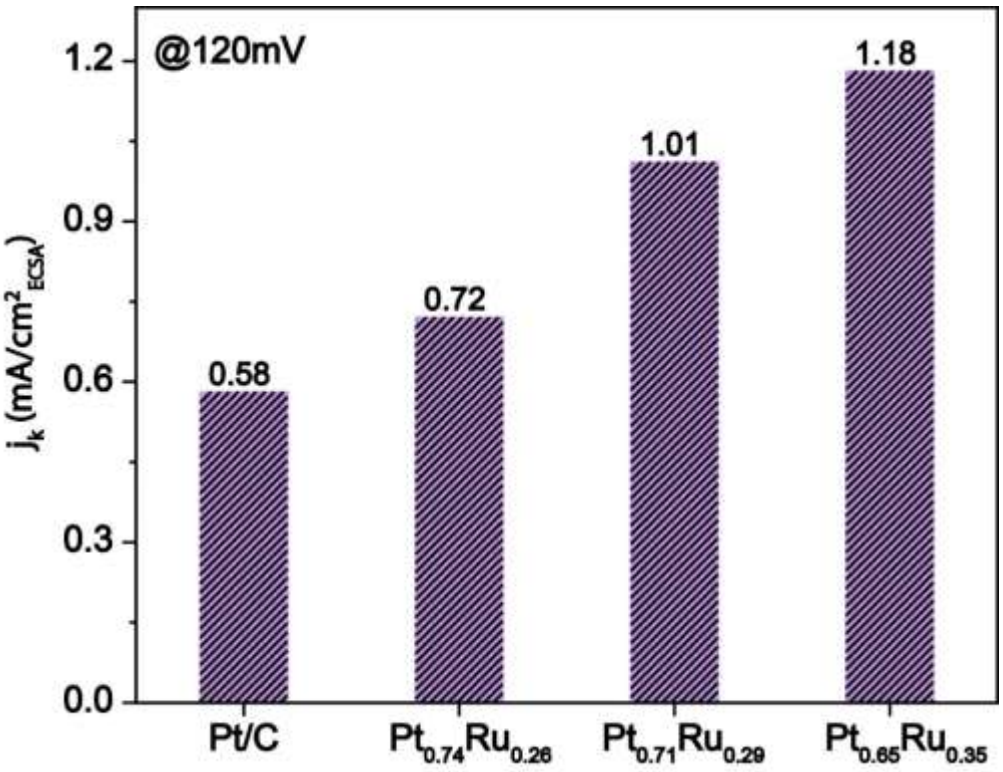

Figure S7. ECSA-normalized kinetic current densities derived from Koutecky–Levich plots for PtRu bimetallic nanoparticles and Pt/C at overpotential of 120 mV.

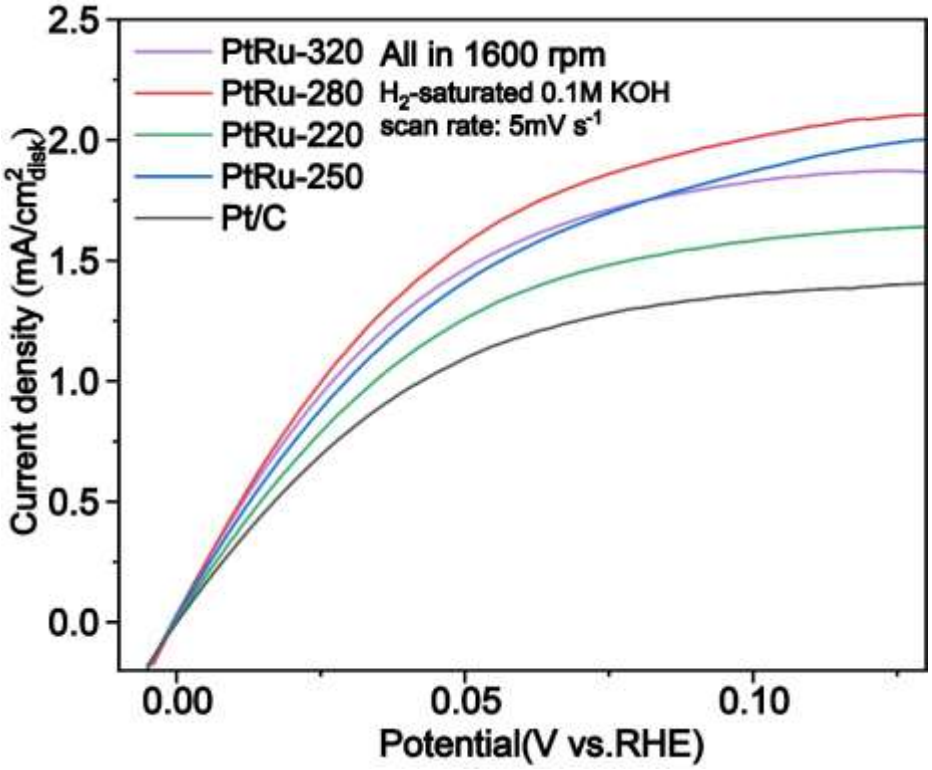

Figure S8. HOR activity comparison. PtRu bimetallic nanoparticles prepared under different temperature.

Table S1. Summary of ICP-MS results for PtRu bimetallic nanoparticles.

	PtRu-220	PtRu-250	PtRu-280	PtRu-320
ratio of Pt	74%	71%	65%	62%
ratio of Ru	26%	29%	35%	38%
Lattice parameter	3.91	3.90	3.89	3.91

Table S2. Summary of binding energies for Pt $4f_{7/2}$ and Pt $4f_{5/2}$ of PtRu-280, PtRu-250, PtRu-220 and Pt/C from XPS results.

Catalyst	Binding energy (eV)			
	Pt $4f_{7/2}$	Pt^{2+} $4f_{7/2}$	Pt $4f_{5/2}$	Pt^{2+} $4f_{5/2}$
PtRu-280	71.66	72.61	75.01	75.96
PtRu-250	71.56	72.36	74.91	75.71
PtRu-220	71.41	72.26	74.76	75.61
Pt/C	71.31	72.51	74.66	75.86

Table S3. Summary of electrochemical surface areas for PtRu bimetallic nanoparticles and Pt/C.

Sample	Electrochemical surface area (m^2/g)
Pt/C	50.5
PtRu-220	34.45
PtRu-250	31.42
PtRu-280	28.42

Table S4. Normalized exchange current densities for PtRu bimetallic nanoparticles and Pt/C.

Sample	j_0 Micropolarization (mA/cm^2_{ECSA})	j_0 Butler-Volmer fitting (mA/cm^2_{ECSA})
PtRu-280	4.16	4.00
PtRu-250	3.41	3.28
PtRu-220	2.75	2.64
Pt/C	1.89	1.76