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# Bringing the Analysis of Electrodeposition Signals in Voltammetry Out of the Shadows

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Voltammetry studies of electrodeposition are growing rapidly. Yet, relations for the analysis of electrodeposition reactions in voltammetry remain relatively obscure in the literature. The existing cyclic and square wave voltammetry relations for electrodeposition and their limitations are discussed to increase awareness. A retrospective analysis is performed to demonstrate the impact of model selection in improving the analysis of electrodeposition behavior with voltammetric data. A repository for voltammetry models of electrodeposition is proposed to further increase familiarity and application of the most appropriate models, which would support a rapidly growing area of research and technological development.

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Foundational texts on electrochemical methods provide an invaluable resource to both new and experienced electrochemists.<sup>1–5</sup> They provide essential content on principles, theories, and techniques in electrochemistry, as well as helpful references for further and deeper study. However, they often focus their treatment of voltammetry on relations developed for soluble-soluble (i.e., reactant and product are soluble in electrolyte) reactions. Within these texts, the delineation between soluble-soluble and soluble-insoluble (i.e., reactant is soluble, but product is insoluble in electrolyte and electrode) reactions for voltammetric relations is often not explicitly discussed, but implicit in the derivations, which can result in ambiguity around the analysis of soluble-insoluble reaction signals in voltammetry.

Over the past couple decades, studies and technologies involving electrodeposition, which is often a soluble-insoluble reaction, have increased rapidly. Based on Google Scholar search results, the keyword “electrochemistry” returned 9,640 publications in 2000 and 48,100 in 2020 (400% increase). Meanwhile, publications found with “electrodeposition” as the keyword grew from 3,910 in 2000 to 25,600 in 2020 (550% increase). Studies found using “electrodeposition” and “voltammetry” grew from 857 in 2000 to 11,800 in 2020 (1,280% increase). Search results in other databases (i.e., Scopus<sup>®</sup>, Web of Science<sup>TM</sup>) reveal the same, consistent trend of voltammetry studies involving electrodeposition becoming a greater share of electrochemistry literature.

Beyond publication trends, electrodeposition plays a critical role in technological advancements, such as lithium metal anodes,<sup>6,7</sup> additive manufacturing,<sup>8</sup> production of critical metals,<sup>9–11</sup> and advanced nuclear reactors and fuel cycles.<sup>12</sup> As more technologies and processes utilize electrodeposition, voltammetry is increasingly being used to improve our ability to monitor, predict, and optimize the behavior of electrodeposition. Hence, the share of researchers and practitioners of electrochemistry who can benefit from the discussion and development of the theory and relations of soluble-insoluble voltammetric signals are increasing. Here, we endeavor to bring the developments and discussion of electrodeposition voltammetry out of the shadows.

## Current State

In presenting the current state of the literature of soluble-insoluble, voltammetric analysis, our discussion and application will focus on molten chloride salts due to our experience and length

constraints. However, the relations and many of the considerations presented are equally applicable to aqueous and other solutions. In fact, the original validation of many relations presented herein took place in aqueous solutions.<sup>13–15</sup> In the presentation of the relations, IUPAC convention will be used.

Our discussion will focus on cyclic voltammetry (CV) and square wave voltammetry (SWV) which are commonly used and particularly affected by the change from a soluble to insoluble product. However, some of the issues discussed here may also apply to other voltammetric techniques. Like the soluble-soluble response, the soluble-insoluble voltammetric response is impacted by the electrochemical reversibility, quasi-reversibility, or irreversibility of the reaction. Additionally, the deposition of the insoluble product onto a foreign substrate (i.e., non-unit activity deposit) or onto the same pure product (i.e., unit activity deposit) influences the response.<sup>14–16</sup> Nucleation and growth mechanisms, two-dimensional (2D) or three-dimensional (3D), may also affect the response.<sup>17</sup> Iso, approximation of analog scans in CV with a digital staircase can impact the soluble-insoluble peak heights more than twice as much as soluble-soluble peak heights.<sup>14</sup> These considerations are all in addition to the general considerations, such as uncompensated resistance distorting the peaks and mimicking irreversible behavior (shifting peak location), covered elsewhere.<sup>1,4,18,19</sup>

**Cyclic voltammetry (reversible).**—For ions being reduced to an electrodeposited metal, the common relation used for electrochemically reversible reactions is the Berzins-Delahay (B-D) equation:<sup>13</sup>

$$I_p = -0.611AC_{Ox}^* \sqrt{D_{Ox} \frac{n^3 F^3}{RT}} \nu \quad [1]$$

where  $A$  is the area of the working electrode (WE),  $C^*$  is the bulk concentration,  $D$  is the diffusion coefficient,  $n$  is the number of electrons exchanged,  $F$  is Faraday’s constant,  $R$  is the universal gas constant,  $T$  is temperature,  $\nu$  is the scan rate, and the subscript  $Ox$  indicates the oxidized species. While the B-D equation is convenient and simple, it is not accurate for deposition onto foreign substrates because unit activity of the deposit was assumed for the reduced species in the Nernst equation in the derivation of Eq. 1. Variation of the activity of the deposit, as it forms and grows, affects the width and height of the peak.<sup>14,20</sup>

Krulic et al. studied the effects of variable activity when depositing onto a foreign substrate and the digital staircase approximation on soluble-insoluble CV peaks and developed the following relations:<sup>14,15</sup>

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$$I_p = -\frac{0.611AC_{Ox}^*}{(1 + 0.588\sqrt{\Delta\varepsilon_s})(1 + 0.16/\chi)}\sqrt{D_{Ox}\frac{n^3F^3}{RT}\nu} \quad [2]$$

where

$$\Delta\varepsilon_s = \frac{nF}{RT}|\Delta E| \quad [3]$$

$$\chi = \frac{C_{Ox}^*}{\Gamma_1}\sqrt{\frac{D_{Ox}RT}{nF\nu}} \quad [4]$$

$\Delta E$  is the step size of the digital staircase approximation of an analog linear scan and  $\Gamma_1$  is the surface concentration of a deposit when the activity of the deposit becomes 1 (i.e., minimum deposit needed for complete coverage of an electrode). For deposition onto a foreign substrate, the leading term in Eq. 1 is not constant, except in the case of  $\Delta E$  approaching zero and full coverage of WE with depositing metal without significantly augmenting the WE area (e.g., dendrites).

$\Gamma_1$  can be approximated by:

$$\Gamma_1 = 1.5\frac{\rho_D(2r_a)}{m_a} \quad [5]$$

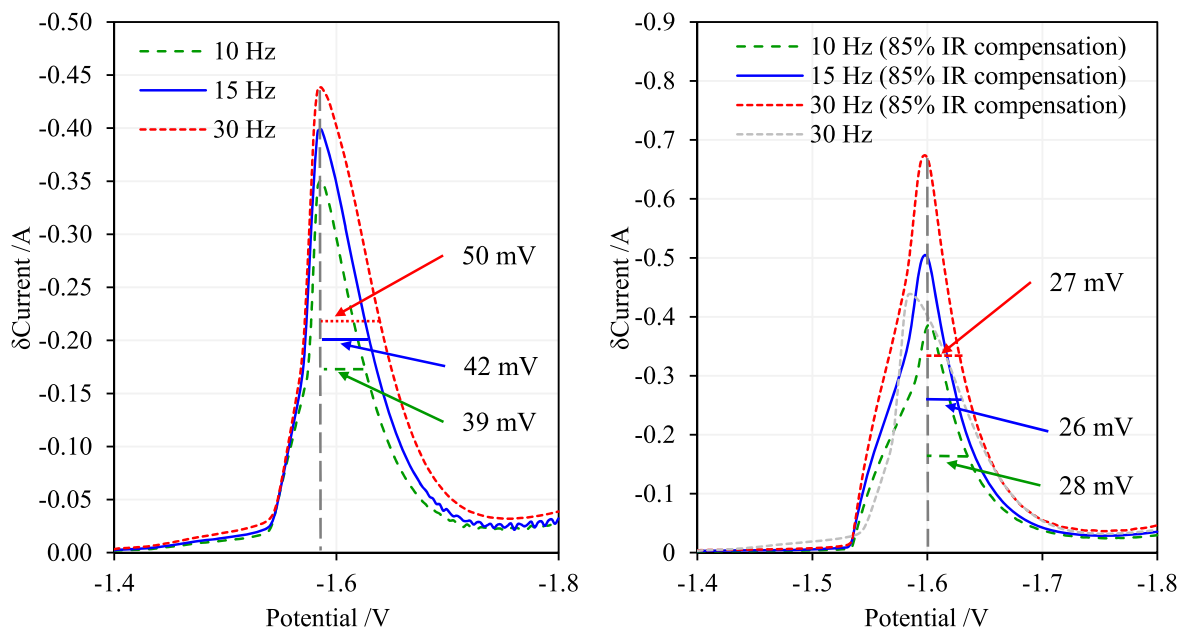
where  $\rho_D$  is the density of the deposit,  $r_a$  is the atomic radius of the deposited metal, and  $m_a$  is the atomic mass of the deposit. A factor of 1.5 is assumed to account for surface roughness and uneven distribution of the deposit. When  $\chi$  is greater than 3,  $I_p$  changes less than 5% as  $\chi$  increases indefinitely. Hence, the estimation of  $\Gamma_1$  becomes less important at lower scan rates and higher concentrations.

When the B-D equation is applied to CV peaks resulting from digital staircase waveforms and/or electrodeposition onto a foreign substrate, property values and concentrations can be drastically underestimated and behavior misinterpreted (e.g., non-linearity of  $I_p$  vs  $\nu^{1/2}$  at low  $\chi$ -values). In molten chloride salts, it is not uncommon to find studies in which diffusion coefficient values calculated from electrodeposition peaks in CV measurements differ significantly from those calculated from other electrochemical methods.<sup>21–32</sup> This is partly due to the application of B-D equation when a foreign substrate and/or digital staircase is used.

A brief retrospective analysis of published data using Eqs. 1 and 2 demonstrates the improved accuracy from increased awareness of the models in Eqs. 1–5 and their limitations. Only previous studies, in which the lead author was involved, were analyzed with Eqs. 1 and 2 because the complete set of necessary parameters were not reported elsewhere.<sup>21–32</sup> Most often, the only missing parameter was  $\Delta E$ . With computer-controlled potentiostats, one cannot assume that an analog scan was applied. Because of the lead author's involvement in some studies,<sup>21–25</sup> it is known that a digital staircase was used with a  $\Delta E$  of 2.24 mV in CV measurements. In reanalyzing the data, concentrations ( $<10^{-4}$  mol cm<sup>-3</sup>) and scan rates ( $\leq 0.3$  V s<sup>-1</sup>) were selected to mitigate the impact of uncompensated resistance on the peak current and to remain within the regime established to be electrochemically reversible (i.e., constant  $E_p$ , linear  $I_p$  with  $\nu^{1/2}$ ) in the published studies.

The results of this revisited analysis are presented in Table I. Columns 4–6 (labeled CA, NPV and CP) in Table I report diffusion coefficients calculated by using the Cottrell equation with chronoamperometry (CA) and normal pulse voltammetry (NPV) data and the Sand equation with chronopotentiometry (CP) data. The B-D (pure deposit, analog scan) and Krulic (foreign substrate, digital staircase) columns are the diffusion coefficients calculated using Eqs. 1 and 2, respectively, with CV data within the scan rate range shown in the  $\nu$  column.

As can be seen in Table I, greater agreement in the calculated diffusion coefficients across methods is achieved when using Eq. 2 to account for non-unit activity of deposits and the use of a digital staircase. The average error of the diffusion coefficient values in the B-D column relative to the values in CA, NPV, and CP columns is 33%. In comparison, the average error of the values in the Krulic column relative to the values in the CA, NPV, and CP columns is 18%, which is largely skewed by CA values in Mn<sup>2+</sup> rows. Without these values, the average error decreases to 9%. The Mn study has the lowest  $\chi$ -values, dropping below 3 at the lowest concentration, which may increase error from the estimation of  $\Gamma_1$ . However, when CP data was available, the Krulic and CP values closely matched. At the low Mn<sup>2+</sup> concentrations, CA may be impacted by nucleation at the sampled time, which is not accounted for in the Cottrell equation. The difference in the diffusion coefficient values within a study were halved on average by applying Eq. 2.



**Figure 1.** SWV plots of LaCl<sub>3</sub> (0.433 wt%) in LiCl at 971 K using a W WE (area = 0.66 cm<sup>2</sup>) without (left) and with (right) ohmic resistance compensation (0.1003 Ω compensated, 0.118 Ω measured), pulse amplitude: 80 mV (peak to peak), potential step: 3 mV, RE: W wire.

**Table I.** Comparison of diffusion coefficients calculated at 773 K in LiCl-KCl eutectic from different electrochemical methods and models. Green and orange highlights indicate closer match to Krulic and B-D calculated values, respectively (footnotes indicate the source of data used to calculate the diffusion coefficient).

Ref.	$Ox$	$C_{Ox}^*/M$	$D_{Ox}/10^{-5} \text{ cm}^2 \text{ s}^{-1}$					$v/V \text{ s}^{-1}$	$\Gamma_1/10^{-10} \text{ mol cm}^{-2}$
			CA	NPV	CP	B-D	Krulic		
21	$U^{3+}$	0.0236	---	1.35 <sup>a</sup>	---	0.91 <sup>b</sup>	1.34 <sup>b</sup>	0.05-0.15	41.7
21	$U^{3+}$	0.0471	---	1.93 <sup>a</sup>	---	1.10 <sup>b</sup>	1.94 <sup>b</sup>	0.05-0.15	41.7
21	$U^{3+}$	0.0719	---	1.92 <sup>a</sup>	---	1.03 <sup>b</sup>	1.81 <sup>b</sup>	0.05-0.15	41.7
22	$La^{3+}$	0.0639	2.06 <sup>c</sup>	---	1.63 <sup>c</sup>	1.04 <sup>d</sup>	1.52 <sup>d</sup>	0.1-0.2	26.0
23	$La^{3+}$	0.0634	---	---	---	1.24 <sup>e</sup>	1.75 <sup>e</sup>	0.1	26.0
24	$Mg^{2+}$	0.0400	---	3.92 <sup>f</sup>	3.80 <sup>f</sup>	2.11 <sup>g</sup>	3.35 <sup>g</sup>	0.15	32.2
25	$Mn^{2+}$	0.0095	1.47 <sup>h</sup>	---	---	1.60 <sup>i</sup>	2.34 <sup>j</sup>	0.1-0.2	56.8*
25	$Mn^{2+}$	0.0192	1.00 <sup>h</sup>	---	1.70 <sup>†</sup>	1.17 <sup>j</sup>	1.60 <sup>j</sup>	0.1-0.2	56.8
25	$Mn^{2+}$	0.0274	1.60 <sup>h</sup>	---	---	1.18 <sup>j</sup>	1.65 <sup>j</sup>	0.1-0.2	56.8
25	$Mn^{2+}$	0.0370	1.30 <sup>h</sup>	---	1.79 <sup>i</sup>	1.18 <sup>j</sup>	1.62 <sup>j</sup>	0.1-0.2	56.8

\* $\chi < 3$  at concentration(s) and scan rate(s), <sup>†</sup>0.0209 M, <sup>a</sup>Figure 12 of Ref. [21], <sup>b</sup>Figure 11 of Ref. [21], <sup>c</sup>Figure 12 of Ref. [22], <sup>d</sup>Figure 7 of Ref. [22], <sup>e</sup>Figure 2 of Ref. [23], <sup>f</sup>Table 4 of Ref. [24], <sup>g</sup>Figure 5 of Ref. [24], <sup>h</sup>Figure 12 of Ref. [25], <sup>i</sup>Figure 14 of Ref. [25], <sup>j</sup>Figure 5 of Ref. [25]

CV peak potential values and behavior are also affected by resistance, non-unit activity of the depositing metal, and step potential, if digital staircase is used, as shown in the equations below (AQ):<sup>15</sup>

$$\frac{nF\eta_p}{RT} = -0.854 - 0.525P - 0.571(1 - e^{-P^{1.177}}) + \Delta\varepsilon_s^{0.467}(0.134 - e^{-(0.722+0.515/\Delta\varepsilon_s^{0.5})P}) - \frac{0.34}{\chi(1 + 0.65P^{2.7})} \quad [6]$$

where

$$\eta_p = E_p - E_{eq} = E_p - E^{o'} - \frac{RT}{nF} \ln(x_{Ox}^*) \quad [7]$$

$$P = \sqrt{\frac{n^5 F^5 D_{Ox} \nu}{R^3 T^3}} R_u A C_{Ox}^* \quad [8]$$

$E_p$  is the peak potential,  $E_{eq}$  is the equilibrium potential,  $E^{o'}$  is the standard apparent reduction potential,  $x_{Ox}^*$  is the bulk mole fraction of the dissolved counter ion and  $R_u$  is the uncompensated resistance. In Eq. 8, the  $P$  represents the influence of resistance,  $\chi$  captures the effect of depositing onto a foreign substrate, and  $\Delta\varepsilon_s$  reflects the impact of step potential when using a digital staircase ( $\Delta\varepsilon_s = 0$  for analog ramp).

**Cyclic voltammetry (quasi-reversible and irreversible).**— Voltammetry models for electrodeposition also have been developed beyond the reversible case. Quasi-reversible relations for soluble-insoluble reactions have been demonstrated under the limited conditions of analog scans and pure metal deposits. Krulic et al. presented results for a transfer coefficient ( $\alpha$ ) of 0.5.<sup>15</sup> Atek et al. developed semi-analytical relations for  $\alpha$ -values of 0 to 1 and validated them with copper deposition onto a copper electrode in an acetonitrile solution.<sup>33</sup> Due to complexity of the relations and space constraints, the relations are not presented herein.

The irreversible relations developed by Delahay<sup>34</sup> and formalized by Nicholson and Shain<sup>2</sup> are applicable to soluble-insoluble systems as well. Since the reverse reaction is negligible, the governing equations and boundary conditions do not consider whether the product is soluble or insoluble.<sup>12,15,33</sup>

**Square wave voltammetry (reversible).**—SWV is often used to verify the number of electrons exchanged. The common approach in the literature for calculating the number of electrons exchanged for electrodeposition involves determining the width of the back half (i.e., the side more negative than the peak potential) of the SWV peak at half peak height ( $w_2$ ), doubling  $w_2$ , and using the relations developed for soluble-soluble reactions.<sup>35,36</sup> This approach effectively results in the following relation:

$$w_2 = 3.52 \frac{RT}{2nF} \quad [9]$$

However, a couple studies have demonstrated that this is theoretically and experimentally inconsistent.<sup>16,37</sup> This is illustrated in Fig. 1 with SWV measurements in molten LiCl containing  $LaCl_3$ . The experimental setup has been reported elsewhere.<sup>37</sup> In the case of no compensation for resistance (left plot),  $w_2$  changes with frequency despite the peak remaining at the same potential, which is often used to verify the applicability of Eq. 9. Values of 2.9, 3.5 and 3.8 are obtained for  $n$  at 30, 15 and 10 Hz, respectively, using Eq. 9. In the work by Fuller et al., this value continues to increase with a decrease in frequency until it settles around a value of 4.6 at 5 Hz or lower.<sup>37</sup> Hence, if fortunate, one will perform SWV at the right frequency which returns the correct  $n$  without ohmic resistance (IR) compensation. However, with IR compensation, a consistent peak potential and  $w_2$  is obtained over the same frequency range. Using Eq. 9, an  $n$  of 5.3–5.7 is calculated from the  $w_2$  obtained when 85% of the IR was compensated (right plot of Fig. 1).

Fuller et al. proposed a relation based on empirical observations of IR compensated experimental data.<sup>37</sup>

$$w_2 = 0.91 \frac{RT}{nF} \quad [10]$$

Using Eq. 10, an  $n$  of 2.7–2.9 is obtained from the 85% IR compensated data. It is important to note that Eq. 10 only applies when: (1) depositing onto an inert, foreign substrate, (2) resistance is well compensated, (3)  $w_2$  is independent of frequency, (4) the absolute value of the pulse amplitude is between  $0.8\text{-}RT/nF$  and  $4.7\text{-}RT/nF$ , and (5) the magnitude of the potential step is between  $0.04\text{-}RT/nF$  and  $0.23\text{-}RT/nF$ .

SWV relations for quasi-reversible, soluble-insoluble systems were not found.

**Table II. Brief descriptions of model parameters, assumptions, and outcomes.**

Cyclic Voltammetry			
Model	Parameters	Assumptions/Limitations	Outcomes
Berzins-Delahay, Eq. 1	WE Area	Negligible WE Area growth	Underpredicted $D_o$ or $C_{Ox}$ with non-pure deposits, significant $R_u$ , and/or digital staircase.
	Temperature Analyte concentration Scan rate	Reversible Activity of metal deposit is 1 (i.e., pure) Negligible $R_u$ Analog sweep	
Fatouros et al., Eq. 2	WE Area	Negligible WE Area growth	Greater agreement of $D_o$ values compared to those from CA, CP, and NPV when depositing onto a foreign substrate and/or using a digital staircase. $R_u$ can still introduce error.
	Temperature Analyte concentration Scan rate Step potential	Reversible 2D deposit growth on foreign substrate Negligible $R_u$	
Krucic et al. Eq. 6	WE Area	Negligible WE Area growth	Greater agreement of estimated $E^{\circ'}$ values compared to open-circuit potentiometry.
	Temperature Analyte concentration Scan rate Step potential $R_u$	Reversible 2D deposit growth on foreign substrate	
Atek et al.	WE Area	Negligible WE Area growth	Ability to estimate kinetic and/or mass transfer properties regardless of reversibility of the reaction.
	Temperature Analyte concentration Scan rate	Negligible $R_u$ Activity of metal deposit is 1 (i.e., pure) Analog sweep	
Square Wave Voltammetry			
"Back-half," Eq. 9	Temperature	Reversible	Inconsistent and inaccurate values for the number of electrons transferred whether $R_u$ is or is not well compensated.
	Frequency <sup>a)</sup>	Negligible effect of pulse amplitude and potential step	
	Pulse amplitude <sup>a)</sup> Potential step <sup>a)</sup>	Negligible $R_u$	

Table II. (Continued).

Cyclic Voltammetry			
Model	Parameters	Assumptions/Limitations	Outcomes
Fuller et al., Eq. 10	Temperature	Reversible	Improved consistency and accuracy values for the number of electrons transferred, if $R_u$ is well compensated.
	Frequency <sup>a)</sup>	Negligible effect of pulse amplitude and potential step	
	Pulse amplitude <sup>a)</sup> Potential step <sup>a)</sup>	Negligible $R_u$	

a) Not used in model, but needed to confirm applicability of model.

## Future Needs and Prospects

Greater effort is needed to improve and share the state-of-the-art measurement procedures and analytical models to support a growing and diverse community of researchers examining electrodeposition with voltammetry. Herein, we have collected references and introduced some relations developed specifically for electrodeposition in CV and SWV. The potential impact of greater awareness of the available models on improving data analysis was demonstrated for  $D_{Ox}$  and  $n$  by replacing Eqs. 1 and 9 with Eqs. 2 and 10, respectively, which account for deposition onto a foreign substrate. Despite the improvements offered by Eqs. 2, 6, 10 and other electrodeposition voltammetry models,<sup>14–16,33,37</sup> they remain relatively obscure and underutilized.

Introduction to electrodeposition voltammetry models in foundational texts can help increase awareness and utilization of the most appropriate models. Qualitative comparisons of the voltammetric responses of soluble-soluble and soluble-insoluble reactions, presentation of B-D relations, and/or brief discussion of voltammetry models for electrodeposition with references in future publications of foundational electrochemistry texts would be highly anticipated additions by a growing share of electrochemists.

Given the incipient and less-proven nature of some relations,<sup>33,37</sup> a dynamic and accessible medium is needed. An open-source, online repository could have the space and adaptability to house existing and emerging electrodeposition voltammetry models. The online repository would accelerate and extend the improvement of voltammetry models for electrodeposition by providing a collection of models specialized for certain conditions of electrodeposition to be vetted and applied more extensively.

Due to several additional factors introduced for electrodeposition, a universal model for electrodeposition peaks in voltammetry is unlikely. For example, Eqs. 2 and 6 assume flat, 2D growth.<sup>14,15</sup> Atek et al.'s quasi-reversible CV relations only apply for instantaneous nucleation.<sup>33</sup> However, nucleation can range from instantaneous to progressive and subsequent growth of nuclei can be 2D or 3D.<sup>17</sup>

There are still other factors to consider in electrodeposition. The growth of the WE surface area during deposition can be significant at slow scan rates, low frequencies, or high concentrations. In molten salts, some metals are soluble (e.g., Ca in  $\text{CaCl}_2$ ) resulting in deposition behavior that is not soluble-insoluble. Alternatively, if the dissolved metal is not the product of analyte reduction, the electrodeposition peak of the analyte could be impacted by the oxidation of the dissolved metal depending upon the relative standard potentials and activities of the deposit and dissolved metal. Electrodeposition can also induce significant convection created from density gradients due to removal of metals from solution near the electrode, especially at high concentrations or for deposition of heavy metals, like lanthanides and actinides.<sup>38,39</sup> This list could go on and easily become overwhelming. However, the significant increase in the accuracy of  $D_{Ox}$  calculated from voltammetry measurements using the models presented herein is promising.

With the online repository, an entire community could be equipped with additional tools to fill the gaps and improve voltammetric analysis of electrodeposition peaks. There are several recent efforts to develop models for electrodeposition voltammetry.<sup>14–16,33,40–42</sup> The repository could help lower the barriers to build upon, validate, and adopt these and future models. Ideally, the programmed models in the repository would be intuitive, easy-to-use, and made available on widely used and/or open-source software programs, such as Microsoft® Excel and Python. Short descriptions of the assumptions and parameters for each model would guide the electrochemist to the most appropriate model and on the inputs needed. As a brief example, Table II provides short descriptions for the models presented herein. Additionally, diagrams depicting each parameter for the voltammetry method would clarify some confusion that arises from parameters and procedures being defined differently across potentiostat software programs,

publications, and models. For example, the pulse amplitude in SWV can be reported as the height of the wave from the center to top or from bottom to top. The envisioned result is that the electrochemist could simply download a programmed voltammetry model, input their experimental parameters and conditions, then calculate the desired property or fit their experimental data. With this increase in accessibility to models, the electrochemist still bears the responsibility to critically determine which models are most appropriate to apply to their data.

To support the creation of the online repository, the authors have uploaded their programmed spreadsheets and python codes for CV and SWV models to their research group's GitHub page (<https://github.com/byu-pyro>). We have attempted to make files intuitive and easy-to-use. We invite others performing and analyzing voltammetry data of electrodeposition to use, provide feedback on, and contribute to the repository.

## Conclusions

As more technologies and studies involve electrodeposition, improving our ability to interpret and quantify the behavior of electrodeposition using voltammetric techniques becomes more critical to optimize operations and to drive innovation. More accurate analysis of electrodeposition properties and behaviors from voltammetric measurements is a key component to improving predictive and monitoring abilities. Significant improvement in the accuracy of property values calculated from voltammetry data was demonstrated by utilizing models which are lesser known, but account for digital approximations of an analog scans and non-unit activity of deposits on foreign substrates. In many instances, the adaptation of the more appropriate models over the B-D relations when analyzing CV data could dramatically improve the accuracy of property values within and across studies. To aid researchers in identifying, adopting, and validating electrodeposition voltammetry models, we have proposed and contributed to the creation of an online, open-source repository for easy-to-use codes and spreadsheets to analyze electrodeposition peaks in CV and SWV. The repository will facilitate more rapid refinement and broader adoption of voltammetry models specifically developed for electrodeposition reactions. The rapid refinement and broader adoption will accelerate our ability to optimize electrodeposition in a variety of existing and emerging technological applications.

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