Electrochemical Characterization of Some Pyrrolo[1,2-c]Pyrimidine Derivatives

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The electrochemical characterization of two pyrrolo[1,2-c] pyrimidine derivatives (**I1** and **I2**) was realized by cyclic, differential pulse, and rotating disk electrode voltammetric methods. The character of redox processes was established by scanning on different domains and with different scan rates. The diffusion coefficients were determined. Modified electrodes have been obtained by cycling the potential or by controlled potential electrolysis at anodic potentials. The electrodes obtained with polyo**I1** and poly**I2** films were characterized by cyclic voltammetry in ferrocene solution.

Keywords: pyrrolo[1,2-c]pyrimidines, cyclic voltammetry, differential pulse voltammetry, rotating disk electrode voltammetry, modified electrodes

Pyrrolo[1,2-*c*]pyrimidine is a nitrogen containing heterocycle which is found in natural products and synthesized bioactive compounds. This class of compounds has been intensively studied [1-8] for its bioactivity (antimicrobial, antitubercular, antifungal, anticancer, antihistamine) and for the fluorescence applications [9-14]: solar cell dyes, organic light-emitting diode (OLED). Some pyrrolo-pyrimidine derivatives are used for their antiproliferative [15], anti-inflammatory and analgesic [16] activity, as well.

For the synthesis of pyrrolo [1,2-c] pyrimidine derivatives different procedures are reported in literature, starting from pyrrole [17, 18] or pyrimidine [19-22]. The 1,3-dipolar cycloaddition of the pyrimidinium *N*-ylides with acetylenic or olefinic dipolarophiles is the most used method. The multistep procedure which leads to pyrrolo[1,2*c*]pyrimidines starts with the preparation of pyrimidinium salts. The second step of this procedure is the reaction between these salts and electronic-deficient alkenes or alkynes in the presence of a base, leading directly to pyrrolo[1,2-c]pyrimidines. The disadvantage of this procedure is the formation of inactivated products from the pyrimidinium-*N*-ylides [23-26]. In order to prevent their formation, a new one-pot three components procedure of synthesis using pyrimidine derivatives, substituted 2bromo-acetophenones, and electron deficient alkynes has been reported. It takes place in the presence of an epoxide, which acts as reaction medium and acid scavenger [27, 28]

The investigation of the electrochemical properties of several pyrrolo[1,2-*c*]pyrimidines is of interest [29] due to the opportunity of using such compounds to obtain electrochemical sensors [29, 30]. This class of compounds also has remarkable fluorescent properties.

The electrochemical characterization of two new pyrrolo[1,2-c]pyrimidines by cyclic voltammetry, differential pulse voltammetry, and rotating disk electrode voltammetry is presented herein, to obtain modified electrodes.

Experimental part

The new pyrrolo[1,2-*c*]pyrimidines were obtained by *one-pot three component* reaction, which involved mixing the reactants (substituted pyrimidine, 2-bromo-acetophenone and diethyl acetylenedicarboxylate or ethyl propiolate, respectively) in 1,2-epoxybutane as reaction medium [24-28]. The structure of the investigated compounds is presented in figure 1.

The electrochemical experiments were performed using a PGSTAT 12 AUTOLAB potentiostat connected to a three-electrode cell (containing acetonitrile and tetrabutylammonium perchlorate (TBAP) from Fluka as solvent and supporting electrolyte salt, respectively). A glassy carbon electrode disk (3 mm diameter) from Metrohm was used as working electrode. Its active surface was polished before each experiment with diamond paste (2 im) and cleaned with acetonitrile. Ag/10 mM AgNO₃ in 0.1 M TBAP, CH, CN was used as reference electrode, and a platinum wire served as an auxiliary electrode. All the potentials were finally referred to the potential of ferrocene/ ferricinium redox couple (Fc/Fc⁺), which was +0.07 V in our experimental conditions. All electrochemical experiments were performed at room temperature (25°C) under argon atmosphere. The cyclic voltammetry (CV) curves were recorded at various scan rates (0.1 – 1 Vs⁻¹), and the different pulse voltammetry (DPV) curves were recorded at 0.01 Vs⁻¹ with a step time of 0.2 s. Rotating disk electrode voltammetry (RDE) experiments were performed at 0.01 Vs⁻¹.



Fig. 1. Structure of investigated compounds

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Fig. 2. DPV (0.01 Vs⁻¹) and CV (0.1 Vs⁻¹) curves on glassy carbon electrode (diameter 3 mm) at different concentrations of **I1** in 0.1M TBAP, CH₃CN; Inset: Corresponding linear dependences of the peak currents on concentration **[I1**]

Results and discussions

The electrochemical characterization of the pyrrolo[1,2*c*]pyrimidines **I1** and **I2** was performed by CV, DPV, and RDE at different concentrations in acetonitrile containing 0.1 M TBAP.

Electrochemical characterization of II

Figure 2 summarizes the CV and DPV curves at different concentrations of **I1** in 0.1 M TBAP,CH₃CN. They were obtained by dilution from the initial 0.75 mM solution which is the highest **I1** concentration in this system. The anodic and cathodic curves were recorded starting from the stationary potential.

DPV curves obtained at different concentrations show five oxidation peaks (denoted a1 - a5 in fig. 2) and four reduction peaks (denoted c1 - c4 in fig. 2), in order of their appearance in the anodic and cathodic scans, respectively. On CV curves only one anodic peak (a1) is obvious, the others appear as shoulders. The three cathodic peaks c1c3 in DPV are seen as shoulders in CV. The notation of the peaks from the DPV curves was kept for all processes taking place at the corresponding potentials in the other methods. The CV and DPV currents are directly proportional with **I1** concentration. The linear dependences of CV and DPV peak currents on **I1** concentration **[I1**] are shown in figure 2 insets for all peaks in DPV and for a1, c1, c2, c3 in CV. Their equations and their correlation coefficients are given in table 1 which contains the peaks with the best correlation coefficients for CV and DPV.

It can be seen that the first anodic peak (a1) and all the cathodic peaks (c1-c4) have good correlation coefficients in DPV. The other peaks are less correlated. This behavior could be explained by occurrence of parallel irreversible electrochemical and chemical processes. a1 slope is the highest, both in CV and DPV, this process being attributed to the formation of radical cation.

Figure 3 shows the anodic and cathodic RDE curves at different rotation rates. In order to establish a correspondence between the processes seen in RDE curves and the peak processes seen in DPV, anodic and cathodic RDE curves were put together with the DPV curve (for the same concentration). RDE cathodic curves obtained for **I1** in 0.1 M TBAP, CH₃CN at different rotation rates are regular. Globally, two waves are seen in the anodic domain, then the currents suddenly drop after reaching the potential of the peak a4. The shape of RDE curves confirms the coverage of the electrode with an insulating layer, in the domain of anodic potentials (at potentials more positive than a4).

Currents are increasing with the rotation rates of RDE. One isosbestic point can be seen for RDE curves at the potential of 1.547 V, which corresponds to an inversion of the current values obtained at different rotation rates.



 Fig. 3. RDE curves (0.01 Vs⁻¹) obtained for different rotation rates in I1 solution (0.5 mM) in 0.1M TBAP,CH₃CN on glassy carbon (3 mm diameter) (a) and their corresponding DPV curves (b)



Fig. 4. CV curves (0.1 Vs⁻¹) at different scan rates for **I1** (0.5 mM) in 0.1M TBAP $CH_{3}CN$ in the domains of peaks a1 and c1 on glassy carbon electrode (3mm diameter) (a) and the dependences of the peak currents on the square root of the scan rate (b)

Method	Equation	Correlation coefficient	
	ipeak al = -0.82 + 22.67 · [I1]	0.956	Table 1
	ipeak a3 = 2.87 + 14.53 · [11]	0.848	EQUATIONS AND
DBV	ipeak a4 = 5.50 + 13.98 · [11]	0.873	CORRELATION
DPV	ipeak cl = -0.65 - 15.76 · [11]	0.939	COEFFICIENT FOR THE
	ipeak c2 = -4.89 - 5.57 · [11]	0.941	DEPENDENCIES ON
	ipeak c3 = -0.08 - 10.40 · [I1]	0.954	CONCENTRATION OF CV
	ipeak c4 = -2.39 - 10.52 · [I1]	0.996	AND DPV PEAK
	ipeak al = 1.99 + 65.16 · [I1]	0.952	CURRENTS FOR 11*
CV	ipeak c2 = -14.11 - 16.29 · [I1]	0.999	
	ipeak c3 = -18.32 - 25.64 · [11]	0.859	\neg

*ipeak is expressed in μA, and [I1] in mmol/L

Starting from this potential (which corresponds to the peak a4 in DPV), the current gets lower to very small values and remains constant over a potential range of about 1 V.

In order to study the processes reversibility, CV curves were recorded at different scan rates (0.1-1 Vs⁻¹) for the first anodic peak a1 and for the first cathodic peak c1 (fig. 4). The cathodic peaks became more evident with the increase of the scan rate. All the current values increase with the scan rate. Linear dependences of the peak currents on the square root of the scan rate are obtained for a1, c1 and c2 with slopes given on the figure 4b.

Figure 5 shows the CV curves (0.1 Vs⁻¹) obtained on different potential domains. The anodic processes are irreversible, while the cathodic ones are mainly quasi-reversible.

Table 2 shows the anodic and cathodic potentials for CV and DPV peaks at and their characteristics issues from the influence of the scan rate and scan domain.



Fig. 5. Anodic and cathodic CV curves (0.1 Vs⁻¹) on different scan domains for **I1** (0.5 mM) in 0.1M TBAP,CH₃CN on glassy carbon electrode (3 mm diameter)

Table 2PEAK POTENTIAL VALUES (V) FROM CV AND DPVCURVES vs FC/FC+ FOR [11] = 0.5 mM

Deals	Method		Process	
геак	DPV	CV	characteristics	
a1	0.867	0.931	irreversible	
a2	1.044	-	irreversible	
a3	1.226	1.293	irreversible	
a4	1.418	1.587	-	
a5	1.829	1.943	-	
c1	-1.947	-1.992	irreversible	
c2	-2.144	-2.207	revesible	
c3	-2.456	-2.518	reversible	
c4	-2.794	-	-	

Polymerization conditions for compound I1

Poly**I1** modified electrodes have been prepared from 0.5 mM solution of **I1** in 0.1 M TBAP, CH₃CN by successive potential scans between -0.3V and different anodic limits (fig. 6). The modified electrodes were transferred in the ferrocene solution (1mM) in 0.1 M TBAP/CH₃CN and their CV curves were recorded and compared to the ferrocene signal on bare electrode (fig. 6f). The signal of ferrocene for the modified electrode prepared by scanning up to 2.02 V is much more diminished than those for other limits. This shows the electrode coverage is much more effective as a result of the process which occurs at this potential. The resulting film by covers much better the electrode.

Modified electrodes have been prepared also by controlled potential electrolysis (CPE). Figure 7a presents the comparison between the CV curves for the modified electrodes prepared by CPE at different potentials and keeping a constant charge. In figure 7b it can be seen that for films of 2 mC the ferrocene current are constant both for the anodic (ipa) and cathodic (ipc) peaks (fig. 7b). However, at higher applied potentials (2.35 V) there is an



Fig. 6. CV curves (0.1 Vs⁻¹) during the preparation of poly**II** modified electrodes by 20 successive potential scans between -0.3 V and different anodic limits: 1.02 V (a), 1.33 V (b), 1.65 V (c), 2.02 V (d), 2.35 V (e) and the corresponding CV curves (0.1 Vs⁻¹) obtained after the transfer of the modified electrode in 1 mM ferrocene solution (f); inset: linear dependences of anodic and cathodic ferrocene peak currents vs limit potential of the anodic scan

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CPE potential	Pulse duration	CPE potential	Pulse duration	CPE potential	Pulse duration
(V)	(5)	(V)	(s)	(V)	(s)
2 1	nC	4 mC		6 mC	
2.35	3.2	2.35	32	2.35	66
2.02	12	2.02	90	2.02	371
1.65	30.4	-	-	-	-
1.33	85	-	-		-
1.02	332	-	-	-	-

3.0x10

2.0x10

1.0x10⁴ ≦ 0.0 -1.0x10⁴

-2.0x10

10 12

2.0x10

ŝ

3.0x10

§ ...

-2.0

b

1.6 1.8 2.0 2.2 2.4

E_{cpe} (V) vs Fc/Fc*

-0.2 -0.1 0.0

f

@ (mC)

E (V) vs Fc/Fc

-0.3

CPE 2.02 V 4mC

0.1 0.2

đ

Table 3CPE DURATION ATDIFFERENT POTENTIAL(V) AND CHARGES(mC)



important decrease of ferrocene anodic and cathodic peak potentials (Epa and Epc, respectively), and also on the formal (Ef) potential (fig. 7c).

0.3

a

E (V) vs Fc/d

Ĉ

(V) VSF0/F0

0.0

E (V) vs Fc/Fc

2.0x10

-2.0x1

Ep (V) vs Fo/Fo

0.0

4.0x

2 Ov10

€

-2.0x10

-0.3

£ ...

[11] = 0.5 ml

-0.2 -0.1 0.0

Higher charges 4 mC and 6 mC have been used for CPE in order to check the increase of the film. Figures. 7d, 7e (fig. 7 f). The ferrocene signal for the modified electrodes obtained at 2 mC for all anodic CPE potentials is close to that to the bare electrode (fig. 7b); this indicates the formation of a thin conducting film. For bigger charges of 4 and 6 mC, the ferrocene signal is more diminished, indicating the fact that thicker films are formed. As the charge is bigger (6 mC), the decrease is more evident. The pulse duration is also important in the film formation (table 3). It can be seen that for the CPEs of 6 mC the pulse at 2.02 V lasts longer (371 s) than the pulse at 2.35 V (66 s). That is why the best coverage of the electrode has been obtained at 2.02 V for a charge of 6 mC, when the time for film formation is bigger.

Electrochemical characterization of I2

The CV and the DPV curves obtained at different concentrations of **I2** (0- 0.75 mM) are shown in figure 8. The DPV curves at different concentrations present six anodic peaks denoted with a1-a6 and three cathodic peaks (c1-c3), in order of their appearance in the voltammograms. The CV curves show five anodic processes denoted in

connection to the DPV peaks (a1 - a5) and four cathodic processes denoted in connection to DPV cathodic peaks (c1-c4).

The currents increase with concentration. The linear dependences of the main peak currents on **I2** concentration for the CV and DPV curves are presented. The equations of the main peak currents on **I2** concentration and their correlation coefficients are given in table 4. The slopes obtained for **I2** (table 4) dependencies are smaller than those for **I1** (table 1). It can be explained by a steric hindrance of the two methoxy groups in **I2**, and it is not correlated with their molar masses (**MI1** < **MI2**).

RDE curves at different rotation rates (500-2000 rpm) for **I2** are presented in figure 9 in comparison with the DPV anodic and cathodic curves. They show two waves in the anodic domain of the peaks a1 and a5 in DPV. The currents increase with the rotation rate. After the peak a5 the current drops suddenly. This behavior is characteristic for the electrode coverage with insulating films. The isosbestic point (at about 2 V) is less marked for **I2**. Also the passive domain is much shorter (0.2 V) than for **I1** (1 V). In the cathodic domain the waves are difficult to be separated. These facts show that the film formed from **I2** after a5 potential is more porous than the corresponding one in case of **I1**.







Fig. 9. RDE curves (a) obtained for **I2** (0.5mM) in 0.1M TBAP, CH_3CN on glassy carbon (3 mm diameter)at different rotation rates





Figure 10 presents the CV curves at different scan rates for **I2** (0.5 mM) in the domain of the peaks a1 and c1. With the increase of the scan rate a new anodic process (d) can be seen, having a corresponding process (d') in the reverse scan. Table 5 present the equations and the correlation coefficients for these peaks. It can be seen that the currents increase with the scan rate. The absolute slope for a1 (~99 μ A (V/s)^{-1/2}) is about twice the slope for c1 (~58 μ A (V/s)^{-1/2}), while that for d (~22 μ A (V/s)^{-1/2}) and d' (~11 μ A (V/s)^{-1/2}) are even smaller. All these facts show that the couple d/d' is due to an impurity in the solvent, while a1 and c1could be attributed to **I2** oxidation and reduction, respectively, because they also depend on **I2** concentration. Their different slopes are due to a different number of electrons involves in the first oxidation and reduction peaks.

 Table 4

 EQUATIONS AND CORRELATION COEFFICIENTS FOR THE

 DEPENDENCES ON 12 CONCENTRATION OF CV AND DPV PEAK

 CURPENTS*

Method	Equation	Correlation coefficient
	ipeak al = -1.38 + 15.69 · [I2]	0.928
	ipeak a2 = 0.82 + 4.23 · [12]	0.903
DPV	ipeak a3 = 0.96 + 13.13 · [12]	0.930
	ipeak cl = 0.99 - 12.80 · [12]	0.994
	ipeak c2 = 0.03 - 4.26 · [12]	0.979
	ipeak c3 = 0.50 - 8.44 · [I2]	0.999
	$i_{\text{peak al}} = -0.03 + 41.03 \cdot [I2]$	0.961
	ipeak a3 = 9.01 + 59.28 · [I2]	0.935
CV	ipeak a6 = 150.47 + 85.58 · [I2]	0.994
	ipeak cl = -6.88 - 24.57 · [12]	0.909
	ipeak c2 = -6.39 - 29.33 · [12]	0.999
	ipeak c3 = -5.8 - 35.05 · [12]	0.999
	ipeak c3 = -9.01 - 51.22 · [12]	0.933



Fig. 11. CV curves (0.1 Vs⁻¹) on different potential domains on glassy carbon electrode (3mm diameter) for I2 (0.5 mM) in 0.1M TBAP CH₂CN

 Table 5

 EQUATIONS AND CORRELATION COEFFICIENTS FOR CV CURVES

 AT DIFFERENT SCAN RATES

Peak	Equation	Correlation coefficient
d	$i_{\text{peak d}} = -2.56 + 21.99 \cdot [v^{1/2}]$	0.997
a1	$i_{\text{peak al}} = -7.65 + 98.69 \cdot [v^{1/2}]$	0.949
ď	ipeak dl' = 2.42 - 11.29 · [v ^{1/2}]	0.941
c1	$i_{\text{peak cl}} = -0.38 - 57.68 \cdot [v^{1/2}]$	0.998

*ipeak is expressed in µA and v is the scan rate (V/s)



Deals	Method		Process	
геак	DPV	CV	characteristics	
a1	0.871	0.943	irreversible	
a2	1.044	-	irreversible	
a3	1.209	1.263	irreversible	
a4	1.522	1.582	irreversible	
aS	1.830	1.970	irreversible	
a6	2.258	2.384	irreversible	
c1	-2.182	-2.190	quasi-reversible	
c2	-2.449	-2.465	quasi-reversible	
c3	-2.516	-2.548	quasi-reversible	
c4	-	-2.914	quasi-reversible	

CV curves for **I2** on different domains (0.1 Vs⁻¹) are presented in figure 11. The processes associated with the curves and their characteristics are shown in table 6. The cathodic peaks are quasireversible.

Polymerization conditions for compound I2

The preparation of modified electrodes based on **I2** was done in a similar way as for **I1** by successive scans (fig. 12), or by CPE at different anodic potentials or charges (fig.

Charges	Pulse duration	Charges	Pulse duration
mC	sec	mC	sec
2.	14 V	2.	.45 V
0.8	8.3	-	-
1.1	10	1.1	8.3
2	16.4	-	-
3	31.7	-	-
4	43.5	4	30.4
6	107.7	6	46.3
8	152.1	-	-

Table 7

CPE DURATION AT DIFFERENT POTENTIAL (V) AND CHARGES (mC)





Fig. 13. CV curves (0.1 Vs⁻¹) in 1 mM ferrocene solutions in 0.1M TBAP, CH₃CN of the modified electrodes prepared by CPE in 0.5 mM solution of **I2** in 0.1M TBAP, CH₃CN at 2.14 V (a) and +2.45 V (b) using different electropolymerization charges; linear dependences of the current vs different charge (c)

Fig. 12. CV curves (0.1 Vs⁻¹) during the preparation of the modified electrodes by scanning (20 cycles) in 0.5 mM solution of I2 in 0.1M TBAP, CH_3CN for different anodic limits: +0.71 V (a), +1 V (b), +1.43 V (c), +2.14 V (d), 2.45 V (e) and the corresponding CV curves (0.1 Vs⁻¹) obtained after the transfer of the modified electrodes in 1mM ferrocene solution (f), inset in figure 14 f: linear dependences of the ferrocene total anodic and cathodic currents on the potentials scan limit

13). The ferrocene signals for the modified electrode obtained at 6 mC and 8 mC are diminished. The decrease is more significant at 2.14 V because the pulse time is bigger ai this potential and there is more time for the polymer formation (table 7), as in the case of **I1**. The electrodes modified with chaarges of 0.3 mC, 0.8 mC, 1 mC and 1.1 mC are practically not covered by films.

Comparison between **I1** and **I2**

From figure 14 and table 8 it can be observed that both compounds are oxidized at about 0.87 V, and **I1** is reduced at less negative potentials than **I2**, as expected taking into account their structures (for **I2** two methoxy groups have a electro donating effect and **I2** is more difficult to be reduced).

From the dependences of the a1 peak currents on the square root of the scan rate (fig. 5 (b) and table 5) the diffusion coefficients have been calculated for the CV

curves recorded at room temperature (298 K), using Randles-Sevcik equation (1), where ip = peak current in A, n = number of electrons transferred in the redox process (is considered 1), A = electrode area in cm^2 , D = diffusion coefficient in cm^2 /s, $C = concentration in mole/cm^3$, and i = scan rate in V/s. The results are summarized in table 9.

$$f_p = 268600 \cdot n^{3/2} \cdot A \cdot C \cdot D^{1/2} \cdot v^{1/2}$$
 (1)

Several differences occur in the preparation of modified electrodes prepared from **I1** and **I2** (fig. 15) either by CPE or scanning. It can be seen that the transfer of the modified

 Table 8

 POTENTIALS vsFC/FC⁺ FROM DPV CURVES (0.5 mM) FOR 11 AND 12

Compound	E al (V)	E cl (V)
11	0.867	-1.947
I2	0.871	-2.182





 Table 9

 DIFFUSION COEFFICIENTS FOR I1 AND I2 (0.5 mM)

Compound	R	10 ⁵ × D
		(cm²/s)
11	2-naphthyl	4.25
12	2,4-dimethoxyphenyl	10.84



Fig. 15. CV curves (0.1 Vs^{-1}) in 1mM ferrocene solutions in 0.1M TBAP, CH₃CN on modified electrodes prepared in 0.5 mM solution of **I1** and **I2** in 0.1M TBAP, CH₃CN by CPE (6 mC) at different electropolymerization potentials (a), and by scanning (20 cycles with the anodic limits of 2.02 V/ 2.14 V, respectively) (b)

			= (1) 101 0110
Compound	11	12	Functional group involved
Peak\R	2-naphtyl	2,4 dimethoxyphenyl	/ assessed process
a1	0.87	0.87	Py/Py ^{+.}
a2	1.04	1.04	
a3	1.23	1.21	Ph (in position 2) (ovidation
a4	1.25	1.21	Fit (in position 3)/ oxidation
aĴ	1.42	1.52	Py/oxidation
аб	1.83	1.83	Py/oxidation
	-	2.26	Py/oxidation
c1	-1.95	-	CO/ CO-/ CHOH/ reduction
c2	-2.14	-2.18	Pyrrole double bonds/ reduction
c3	-2.46	-2.45	Ester/ reduction
	-2.79	-2.55	Pyrimidine/ reduction

Table 10ROUNDED VALUES FOR THEPEAK POTENTIALS (IN V)FROM DPV AND THEIRASSESSMENT FOR 11 AND 12

electrodes (in 1 mM ferrocene solution) obtained by CPE at the same charge (6 mC) and at close potentials (2.02 V for compound **I1**, and 2.14 V for compound **I2**), the signal for ferrocene is more flat for **I1**, indicating a less conducting film (fig. 15a). The electrode seems to be better covered by **I1** than **I2**. However, when the films are prepared by cycling the differences are less significant (fig. 15b). This behavior could be explained by the fact that the preparation of the modified electrodes takes longer by scanning (than by CPE) for both **I1** and **I2**, and the polymerization step can occur better.

Pyrrolo[1,2-c]pyrimidine is a complicated redox system, due to its relatively low aromatic character, which confers it a high reactivity in comparison to the common aryls. The difficulty of the peak assessment is increased by the presence of stabilizing functional groups, which have redox potentials close to the aromatic moiety (table 10).

An important description of the electrochemical processes have been already given by our group in 2012. [29]. However, the change of substituents leads to important changes of their electrochemical behaviour. For example, an extra OMe group attached to R = alkoxyphenyl reduces the oxidation potentials with about 0.1 V, but does not affect the reduction potentials, which remain at about 1.94V. When two dimethoxybenzene units are present, as in **I2**, they oxidize to ortho-quinones at diferrent potentials, as it can be seen by the increase of the number of peaks in DPV curves for this compound. When the extra methoxy group is placed on the benzoyl substituent, the reduction

potential is increased by 0.25 V to -2.18 V. These data prove that the keto group is firstly involved into system reduction to alcohol, followed by the heterocycle moiety reduction. The reducing steps of the pyrrolo[1,2-c]pyrimidines are quasi-reversible due to the partial opening of the pyrrole ring.

Conclusions

The new pyrrolo[1,2-*c*]pyrimidines have been characterized by electrochemical methods. By cycling the potential in different anodic domains or by controlled potential electrolysis at anodic potentials poly**I1** and poly**I2** films were deposited on to the electrodes. The modified electrodes were characterized in ferrocene solution in 0.1 M TBAP, CH₃CN. A decrease of Fc/Fc⁺ current has been seen, confirming the electrode coverage by films.

Further studies will be directed to investigations of poly**I1** and poly**I2** modified electrodes in view of their direct relevance in practical applications.

Acknowledgements: The authors are grateful for the financial support from: Executive Unit for Financing Education Higher, Research Development and Innovation (UEFISCDI) project ID PN-II-RU-TE-2014-4-0594 contract no. 10/2015, PN-II-PT-PCCA-2013-4-2151 contract no. 236/2014, and Romania–China bilateral project 68BM/2016 (CH 41.16.04).

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Manuscript received: 5.10.2017