[Article]

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MgCl₂在LiCl-KCl熔盐中的电化学特性

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摘要: 研究了温度范围在 723–908 K 的 LiCl-KCl 熔盐体系中 MgCl₂ 的电化学行为和热力学性质. 循环伏安和方波伏安法研究表明镁离子的电化学还原过程为包含了两个电子转移的一步反应. 利用 Berzins 和 Delahay 方程计算了不同温度下的镁离子的扩散系数, 并通过 Arrhenius 公式计算了镁离子在 LiCl-KCl 熔盐体系中的扩散活化能. 采用开路计时电位法得到了不同温度下的 Mg(II)/Mg(0) 体系的平衡电位, 并结合电动势法计算了在 LiCl-KCl 熔盐体系中 Mg(II)/Mg(0) 体系的标准形式电位. 根据不同温度下的标准形式电位, 计算得到了 MgCl₂ 在 LiCl-KCl 熔盐体系中的熵变和焓变以及不同温度下的活度系数.

关键词: 氯化物熔盐; 热力学性质; MgCl₂ 活度系数; 标准形式电位

中图分类号: O646

Electrochemistry of MgCl₂ in LiCl-KCl Eutectic Melts

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Abstract: The electrochemical behavior and thermodynamic properties of MgCl₂ dissolved in LiCl-KCl eutectic melts in the temperature range of 723–908 K were investigated. Cyclic and square wave voltammetry experiments indicated that the reduction of Mg ions into Mg metal occurred in a single step and involved exchange of two electrons. The diffusion coefficient (*D*) of Mg(II) was determined by the Berzins-Delachay equation and the Arrhenius law was validated by plotting $\lg D$ versus T^{-1} for the reduction of Mg(II). Open circuit chronopotentiometry was used to determine the equilibrium potential of Mg(II)/Mg(0). The standard apparent potentials of the Mg(II)/Mg(0) system and the activity coefficients of Mg(II) in LiCl-KCl eutectic melts based on a pure supercool reference state were calculated at several temperatures.

Key Words: Molten chloride; Thermodynamic property; Activity coefficient of MgCl₂; Standard apparent potential

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1 Introduction

Magnesium, with a density of $1.74 \text{ g} \cdot \text{cm}^{-3}$, is the lightest structural metals used as engineering materials, known as “21st Century Green Engineering Materials”. Magnesium base materials have been widely used in the area of transportation, communication, electronic, aerospace, and sports industries,^{1–3} because magnesium base materials exhibit a series of favorable properties, such as high specific strength and stiffness, superior machinability, and better electromagnetic shielding properties, etc.^{1,4} Rare earth (RE) elements are often used as addition elements to improve alloys properties. The additions of small amount of RE elements to Mg alloys can improve castability, high temperature properties, mechanical properties, and corrosion resistance due to ageing, fine grain, dispersion, and solid solution strengthening.^{5–7} In fact, high cost is the only one negative factor that limits the range of applications of Mg-RE alloys.

Electrolysis in molten chlorides and fluorides is still the main method for industrial production of pure Mg and RE metals. This is an energy demanding process. To date, Mg-RE master alloys are mainly prepared by mixing pure Mg and RE metals directly at temperatures above their melting points. These production processes result in high energy waste. In recent years, electrochemical co-deposition has been widely used to prepare RE alloys in different mediums. Iida *et al.*⁸ investigated the electrochemical co-deposition of Sm-Co alloys from $\text{LiCl-KCl-SmCl}_3\text{-CoCl}_2$ melts. Li and co-workers⁹ prepared Sm-Co films on copper substrate by electrodeposition in urea-acetamide- NaBr-KBr melt at 353 K. Li *et al.*¹⁰ prepared Er-Bi films by co-deposition from $\text{ErCl}_3\text{-Bi(NO}_3)_3\text{-LiCl-DMSO}$ on copper substrate at 305 K. Massot *et al.*^{11–13} have prepared Al-RE alloys by co-reduction of RE ions with Al ions to recover REs from molten fluorides. The extraction efficiency was greater than 95%. RE have been also reclaimed from molten LiCl-KCl melts by co-reduction of Al, RE, and Li ions to form Al-Li-RE alloys.^{14–16} Hence, the method of electrochemical co-deposition is possible to provide a unique opportunity, which can improve the energy efficiencies and achieve cost-competitive production, for the preparation of Mg-RE master alloys in molten salts.

Electrolysis of magnesium in industry is a mature technology. In terms of production of pure magnesium metal, co-deposition process has adverse effect, which would introduce impurities to the products. To avoid the co-deposition reaction, the concentration of MgCl_2 in the electrolyte of industrial process is very high. However, this kind of electrolyte in industrial production is not suitable for preparation of Mg-RE alloys. Here, LiCl-KCl melts, which have low melting temperature, high conductivity, and low density, were selected to investigate the co-deposition process in our group. LiCl-KCl eutectic has the advantages of high conductivity, relatively low viscosity and operating temperature. The low operating temperature allows simpler design, with reduced energy consumption, salt volatili-

ty, and cell corrosion. Therefore, LiCl-KCl melts are promising molten salts for preparation of magnesium alloys at a temperature lower than the melting points of magnesium metal. Our group^{17–19} already has abundant experience in preparation of Mg-Li-RE alloys. However, the content of REs is small in these materials prepared by electrolytic co-reduction. At present, our group wants to directly extract REs with the assistance of Mg ions in LiCl-KCl eutectic melts at a low temperature by fabrication of Mg-RE alloys which contain a large amount of REs. According to co-deposition theory, deposition potential and the ratio of the feeds determine the constitution of the products. Therefore, thorough understanding of the thermodynamic properties and electrochemical behavior of Mg ions in the melts is critical to their co-deposition process. Moreover, basic electrochemistry data can provide abundant information to design an effective deposition apparatus.

In recent years, electrochemical behavior of rare earths in LiCl-KCl melts has been intensively studied because of pyro-metallurgical reprocessing technology.²⁰ These basic data give us abundant information to study how to extract REs from molten salts *via* electrolytic reduction. The electrochemical behavior of magnesium and the electrodeposition of pure magnesium have been studied in LiCl-KCl melts.^{21,22} Cyclic voltammetry and chronopotentiometry have been employed to determine the diffusion coefficients of Mg(II) species ($D_{\text{Mg(II)}}$) in LiCl-KCl eutectic melts in the temperature range of 673–773 K. The effect of the temperature on the value of $D_{\text{Mg(II)}}$ has also been determined by plotting the $\ln D$ versus T^{-1} . The activation energy for this diffusion process is $33.1 \text{ kJ} \cdot \text{mol}^{-1}$. Hamer *et al.*²³ have calculated the theoretical electromotive forces of $\text{Mg/MgCl}_2/\text{Cl}_2$ according to the thermodynamic data. Laitinen and Liu²⁴ have measured Mg/MgCl_2 system in LiCl-KCl eutectic melts at 723 K. However, based on our knowledge, the standard apparent potentials of Mg(II)/Mg(0) system and the activity coefficients of Mg(II) ions in a wide temperature range have not been investigated in LiCl-KCl eutectic melts so far. On the basis of these backgrounds, we propose to systematically investigate the electrochemical behavior and thermodynamic properties of Mg ions in LiCl-KCl eutectic melts. The results will help us to further study the co-deposition of Mg-RE alloys which contain large quantity of RE.

2 Experimental

2.1 Preparation and purification of the melts

All operations of the salts were carried out in a glove box under a high purity argon gas (99.999%) previously dehydrated by heating in a vacuum. Purchased anhydrous lithium chloride (99.0%) and potassium chloride (99.5%) were first dried under high vacuum for more than 72 h at 473 K to remove possible physical moisture. And then the mixture of eutectic LiCl-KCl ($n_{\text{LiCl}}:n_{\text{KCl}}=58.8:41.2$) was introduced to an alumina crucible placed in a cylindrical quartz cell located in an electric furnace. The electrolyte was melted under the dry argon gas and the

temperature of the melts was monitored with a nickel-chromium thermocouple sheathed with an alumina tube. Magnesium element was introduced into the bath in the form of anhydrous MgCl_2 (99.0%) powder.

2.2 Electrochemical apparatus and electrodes

All electrochemical measurements were performed using Im6eX electrochemical workstation (Zahner Co., Ltd.) with the THALES Z1.31 software package. The reference electrode was fabricated by a silver wire ($d=1$ mm, 99.99% purity) dipped into a solution of AgCl (1%, mass fraction) in the LiCl-KCl eutectic contained in a Pyrex tube. All potentials were referred to this Ag/Ag^+ couple. The counter electrode was a spectral pure graphite rod ($d=6$ mm). The working electrodes were tungsten (W) wires ($d=1$ mm, 99.99% purity), which were polished thoroughly using SiC paper, and then cleaned ultrasonically with ethanol prior to use. Between each measurement the W working electrode was cleaned by applying an anodic polarization. The active electrode surface area was determined after each experiment by measuring the immersion depth of the electrode in the molten salts.

3 Results and discussion

3.1 Cyclic voltammetry

Fig.1 illustrates the cyclic voltammograms obtained on tungsten electrodes in LiCl-KCl eutectic melts before and after the addition of MgCl_2 at 723 K. The cyclic voltammogram of the purified melts is the dashed line in Fig.1. The sharp increase of cathodic current from about -2.44 V (vs Ag/Ag^+) and the corresponding anodic current are considered to be the reduction of lithium metal and the reverse reaction, respectively. In the positive potential region, the quick rise of anodic current is observed from about 1.20 V, which is considered as the oxidation of chloride ions to chlorine gas. There are no other additional peaks within the electrochemical window, which indicates that the melts are suitable for investigations. The solid line in Fig.1 shows the cyclic voltammogram containing MgCl_2 in the LiCl-KCl eutectic melts. The reduction peak A, at approximately -1.90 V, shows a stepped rise and gradual decay associated

Fig.1 Cyclic voltammograms obtained on W electrodes ($S=0.322$ cm²) in the LiCl-KCl eutectic melts before and after the addition of 1.18% (mass fraction) MgCl_2
 $T=723$ K, scan rate= 0.1 V $\cdot$ s⁻¹

with Mg(II) reduction, characteristic of deposition of a new insoluble phase on the inert electrode limited by diffusion.²⁵ The reverse anodic scan shows an oxidation peak A' of the depletion of the deposited Mg metal. The cathodic peak B at about -2.36 V is attributed to the underpotential deposition of Li on pre-deposited Mg film to form Mg-Li alloys, and the corresponding anodic peak B' is found at around -2.31 V.

The reversibility of $\text{Mg(II)}/\text{Mg(0)}$ system was evaluated from 723 to 908 K and the results were similar. Fig.2(a) shows the voltammograms obtained upon deposition and dissolution of $\text{Mg(II)}/\text{Mg(0)}$ system at different sweep rates at 823 K. In excess of about 0.30 V $\cdot$ s⁻¹, peak potentials clearly shift toward more negative potentials with the increase of scan rate. This is characteristic of a reaction limited by electron transfer. Further-

Fig.2 (a) A series of voltammograms related to the reduction of Mg(II) on a W electrode ($S=0.322$ cm²) in the LiCl-KCl eutectic melts containing 1.18% of MgCl_2 ; (b) variation of the cathodic peak current with the square root of the scan rate; (c) variation of the cathodic peak potential with the logarithm of the scan rate

more, a further analysis of the recorded voltammograms is based on the measurement of the variation of peak potentials and peak currents as scan rates change, according to the methodology proposed in the literature.^{25–27} Fig.2(b) illustrates that the plot of I_{pc} vs $v^{1/2}$ (I_{pc} is the cathodic peak current and v is the scan rate) is a line from the origin at low scan rates. Moreover, the peak potentials are almost constant until scan rate is greater than $0.30 \text{ V} \cdot \text{s}^{-1}$ (Fig.2c). The behaviors revealed from Figs.2a to 2c are characteristic of a quasi-reversible system where the electrochemical reaction is controlled by the mass transfer rate at low scan rates. Nevertheless, for scan rates greater than $0.30 \text{ V} \cdot \text{s}^{-1}$, the electron transfer rate predominates the electrochemical reaction.

3.2 Square wave voltammetry

Square wave voltammetry has been carried out to calculate the number of electrons involved in the magnesium reduction process. According to the literature,^{28,29} for a reversible system, the mathematical analysis of a square wave voltammogram yields a simple equation relating the width of the half peak ($W_{1/2}$) and the number of exchanged electrons:

$$W_{1/2} = 3.52RT/nF \quad (1)$$

where R is the universal gas constant, T is the absolute temperature, n is the number of exchanged electrons, and F is the Faraday's constant.

Eq.(1) also can be utilized to estimate the number of electrons involved in the reaction of Mg(II)/Mg when we apply this technique at low frequencies and small step potentials. Fig.3 shows a square wave voltammogram obtained at a step potential of 1 mV and frequency of 10 Hz in the LiCl-KCl-MgCl₂ system for the reduction of Mg(II) on a tungsten electrode at 823 K, in which the reaction was in the reversible range. A single peak at -1.79 V was observed and the computed value of n is 1.92 ± 0.10 , close to two electrons, which is related to the reaction of Mg(II)/Mg.

3.3 Diffusion coefficient

Diffusion coefficient of Mg(II) in LiCl-KCl eutectic was determined in the temperature range of 723–908 K by cyclic voltammetry. For Mg(II)/Mg(0) system, at low scan rates, the Berzins and Delahay equation³⁰ can be used to estimate the dif-

Fig.3 Net-current square wave voltammogram for the reduction of Mg(II) at a W electrode (0.322 cm^2) at 823 K pulse height: 25 mV; potential step: 1 mV; frequency: 10 Hz

fusion coefficient from the following formula:

$$I_p = 0.6105(nF)^{3/2} SC_0 D^{1/2} v^{1/2} (RT)^{-1/2} \quad (2)$$

where I_p is the peak cathodic current (A), S is the electrode surface area (cm^2), C_0 is the bulk concentration of Mg ion ($\text{mol} \cdot \text{cm}^{-3}$), D is the diffusion coefficient ($\text{cm}^2 \cdot \text{s}^{-1}$), v is the potential sweep rate ($\text{V} \cdot \text{s}^{-1}$).

The obtained diffusion coefficient values at different temperatures are listed in Table 1. The influence of the temperature on the value of D was determined by plotting the $\lg D$ versus T^{-1} , as shown in Fig.4. The trend shown in Fig.4 is described by

$$\lg D_{\text{Mg(II)}} = -2.19 - 2037/T \quad (3)$$

The results obey the Arrhenius's law expressed as

$$D = D_0 \exp(-E_A/RT) \quad (4)$$

where D_0 is the coefficient of the Arrhenius equation and E_A the activation energy for diffusion. From the relationship (3), the value of the activation energy for diffusion of Mg(II), was computed to be $(39.0 \pm 2.5) \text{ kJ} \cdot \text{mol}^{-1}$. It is slightly higher than the value obtained by Større²² who found E_A to be $33.1 \text{ kJ} \cdot \text{mol}^{-1}$. This discrepancy may be attributed to the different temperature ranges.

3.4 Equilibrium potential and apparent standard potential

EMF measurements were performed to determine equilibrium potential for calculating the apparent standard potential.³¹ For each temperature, the tungsten electrode was coated with Mg film by applying a cathodic potential for 60 s, and the open-circuit potential (OCP) was recorded versus the Ag/Ag⁺ reference electrode (Fig.5). A very stable plateau was obtained each time, allowing the measurement of the corresponding equilibrium potential E^{eq} . The measured potential for a metal in equilibrium with its metal chloride, in this case the Mg(II)/Mg(0) couple, is determined by the Nernst relationship.

$$E_{\text{Mg(II)/Mg(0)}}^{\text{eq}} (\text{V vs Ag/Ag}^+) = E_{\text{Mg(II)/Mg(0)}}^0 + \frac{RT}{nF} \ln \frac{a_{\text{Mg(II)}}}{a_{\text{Mg(0)}}} \quad (5)$$

Table 1 Diffusion coefficient of Mg(II) ions in a molten LiCl-KCl eutectic at different temperatures

T/K	723	773	823	868	908
$10^{-5} D_{\text{Mg(II)}}/(\text{cm}^2 \cdot \text{s}^{-1})$	0.92 ± 0.03	1.57 ± 0.03	2.31 ± 0.07	2.80 ± 0.05	3.14 ± 0.14

Fig.4 Variation of diffusion coefficient of Mg(II) with temperature in the LiCl-KCl eutectic melts

Fig.5 Typical open-circuit potential transient curve for a W electrode after electrodepositing at -2.00 V (vs Ag/Ag $^{+}$) for 60 s in the LiCl-KCl eutectic melts containing 1.18% MgCl $_2$ at 823 K

where $E_{\text{Mg(II)/Mg(0)}}^0$ is the standard potential at a hypothetical supercooled liquid reference state of unit mole fraction and unit activity, $a_{\text{Mg(II)}}$ and $a_{\text{Mg(0)}}$ are the activities of Mg ions and metallic Mg, respectively. Unit activity was assumed for pure metal.

The apparent standard potential, $E_{\text{Mg(II)/Mg(0)}}^{*0}$ of the Mg redox couple is defined as

$$E_{\text{Mg(II)/Mg(0)}}^{*0} = E_{\text{Mg(II)/Mg(0)}}^0 + \frac{RT}{nF} \ln \gamma_{\text{Mg(II)}} \quad (6)$$

where $\gamma_{\text{Mg(II)}} = a_{\text{Mg(II)}}/X_{\text{Mg(II)}}$, is the activity coefficient of Mg(II), and $X_{\text{Mg(II)}}$ is the molar fraction of Mg(II) in the salt. Combining Eq.(5) and Eq.(6), can be expressed as

$$E_{\text{Mg(II)/Mg(0)}}^{\text{eq}} (\text{V vs Ag/Ag}^{+}) = E_{\text{Mg(II)/Mg(0)}}^{*0} + \frac{RT}{nF} \ln X_{\text{Mg(II)}} \quad (7)$$

The potential data have been calculated versus the Cl $_2$ /Cl $^{-}$ reference electrode, according to the following equation:

$$E_{\text{Ag/AgCl}} (\text{V vs Cl}_2/\text{Cl}^{-}) = E_{\text{AgCl}}^0 + \frac{RT}{nF} \ln X_{\text{AgCl}} \quad (8)$$

Based on extrapolation to infinite dilution of the data of Yang and Hudson³² at low AgCl concentrations in the LiCl-KCl eutectic and other references,^{31,33} the potential of the reference electrode used in this work (0.0039 mole fraction AgCl) versus Cl $_2$ /Cl $^{-}$ is given by the expression

$$E_{\text{AgCl}} (\text{V}) = -1.0910 - 1.855 \times 10^{-4} T (\text{K}) \text{ with } X_{\text{AgCl}} = 0.0039 \text{ (i.e. 1\%)} \quad (9)$$

Table 2 summarizes the experimental data obtained from Mg deposited on a tungsten wire by open circuit potentiometry. Fig.6 shows the variation of standard potential with temperature computed from the experimental data of Table 2. The experimental data of the present study (shown by the line) can be described by

Table 2 Experimental data for apparent standard potential and standard potential of Mg(II)/Mg(0) in the LiCl-KCl eutectic melts

T/K	$E_{\text{Mg(II)/Mg(0)}}^{\text{eq}}/\text{V}$ (vs Ag/Ag $^{+}$)	$E_{\text{Mg(II)/Mg(0)}}^{*0}/\text{V}$ (vs Ag/Ag $^{+}$)	$E_{\text{Mg(II)/Mg(0)}}^{*0}/\text{V}$ (vs Cl $_2$ /Cl $^{-}$)
723	-1.820	-1.665	-2.890
773	-1.780	-1.615	-2.849
823	-1.743	-1.567	-2.811
868	-1.705	-1.519	-2.771
908	-1.670	-1.476	-2.735

Fig.6 Variation of the standard potential of Mg(II)/Mg(0) with temperature in the LiCl-KCl eutectic melts

$$E_{\text{Mg(II)/Mg(0)}}^{*0} (\text{V vs Cl}_2/\text{Cl}^{-}) = -3.494 + 8.332 \times 10^{-4} T (\text{K}) \quad (10)$$

3.5 Gibbs free energy and activation coefficient

The standard potential relationship of Eq.(10) can be used to compute the Gibbs free energy of formation and subsequent dissolution of the reaction

according to the relationship

$$\Delta G_{\text{MgCl}_2}^{*0} = -nFE_{\text{Mg(II)/Mg(0)}}^{*0} \quad (12)$$

where $\Delta G_{\text{MgCl}_2}^{*0}$ is the Gibbs free energy (kJ $\cdot$ mol $^{-1}$) of the dissolved metal chloride, calculated from the experimentally-determined standard potential, $E_{\text{Mg(II)/Mg(0)}}^{*0}$, Gibbs free energy is also a function of temperature, following the form

$$\Delta G_{\text{MgCl}_2}^{*0} = \Delta H_{\text{MgCl}_2}^{*0} - T\Delta S_{\text{MgCl}_2}^{*0} \quad (13)$$

from which the enthalpy and entropy can be obtained. The values from the present study were plotted versus temperature, and the relationship was drawn to be

$$\Delta G_{\text{MgCl}_2}^{*0} = -674.3 + 0.1608T \quad (14)$$

The activity coefficient of MgCl $_2$ in LiCl-KCl eutectic melts was determined from the difference between the Gibbs energy of formation derived from the electrochemical measurements and the Gibbs energy of formation for pure compounds in the supercooled state, according to the equation:

$$2.303RT \lg \gamma_{\text{MgCl}_2} = \Delta G_{\text{MgCl}_2}^{*0} - \Delta G_{\text{MgCl}_2(\text{sc})}^0 \quad (15)$$

Where $\Delta G_{\text{MgCl}_2(\text{sc})}^0$ is the Gibbs energy of formation from reaction of the pure compounds in the supercooled (sc) state. The Gibbs energy of formation of MgCl $_2$ in the supercooled state was calculated according to Eqs.(16, 17), in which the thermochemical data of Mg, Cl $_2$, and MgCl $_2$ in 298 K were obtained from literature.³⁴ The thermodynamic data are summarized in Table 3.

Table 3 Activity coefficient for MgCl $_2$ ($X_{\text{Mg(II)}} = 7.002 \times 10^{-3}$) in the LiCl-KCl eutectic melts

T/K	$\Delta G_{\text{MgCl}_2}^{*0}/(\text{kJ} \cdot \text{mol}^{-1})$	$\Delta G_{\text{MgCl}_2(\text{sc})}^0/(\text{kJ} \cdot \text{mol}^{-1})$	γ_{MgCl_2}
723	-557.77	-524.40	3.88×10^{-3}
773	-549.86	-516.78	5.82×10^{-3}
823	-542.52	-509.22	7.70×10^{-3}
868	-534.80	-502.43	1.13×10^{-2}
908	-527.86	-496.43	1.56×10^{-2}

$$G_T^0 = H_T^0 - TS_T^0$$

$$= (H_{298}^0 + \int_{298}^T C_p dT) - T \left(S_{298}^0 + \int_{298}^T C_p d \ln T \right) \quad (16)$$

$$\Delta G_{\text{MgCl}_2(\text{sc})}^0 = G_{\text{MgCl}_2}^0 - G_{\text{Mg}}^0 - G_{\text{Cl}_2}^0 \quad (17)$$

4 Conclusions

Electrochemical properties of MgCl₂ were studied using cyclic voltammetry and square wave voltammetry in the eutectic LiCl-KCl mixture in the temperature range of 723–908 K on a W electrode. The reduction of Mg(II) to Mg metal is a quasi-reversible system and occurs with two electrons exchange. The diffusion coefficients of the Mg(II) ions were calculated at several temperatures. At 903 K (a suitable temperature to co-reduction of Mg-RE alloys), the diffusion coefficient is $3.58 \times 10^{-5} \text{ cm}^2 \cdot \text{s}^{-1}$, and the data reveal that a temperature dependence complies with Arrhenius law. Moreover, by using EMF measurements the standard apparent potential of Mg(II)/Mg(0) redox systems is found to be $E_{\text{Mg(II)/Mg(0)}}^* = -2.742 \text{ V (vs Cl}_2/\text{Cl}^-)$. According to the standard apparent potentials at different temperatures, the values of enthalpy and entropy changes are -674.3 and $0.1608 \text{ kJ} \cdot \text{mol}^{-1}$, respectively. Furthermore, we have established the method to calculate the activity coefficient of MgCl₂ in the LiCl-KCl eutectic melts at different temperatures.

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第十七次全国电化学大会第二轮通知

第十七次全国电化学大会定于2013年11月15日-19日在苏州大学召开。本次大会由中国化学会电化学委员会主办,苏州大学承办。大会旨在全面展示我国电化学领域所取得的最新进展及成果,增进产、学、研、用之间的技术交流与合作,进一步促进我国电化学事业的发展。届时将邀请国内外知名电化学专家、学者和电化学科技工作者,并邀请大陆、港、澳、台地区和海外从事电化学仪器开发以及产业界同仁聚会苏州,交流和展示最新成果。

本次会议的学术交流形式包括大会邀请报告、分会邀请报告、口头报告和墙报等多种形式。大会还设有产品及仪器展示和电化学仪器新技术专题讨论。现面向全国广大电化学工作者征集学术论文,并制作论文集,欢迎踊跃投稿,积极参会。

本次大会将于11月15日(星期五)全天举办首届电化学专题讲座。

论文征集

1、征文范围

本次会议征文对象为从事电化学领域的工作者,应征论文应是未曾公开发表的研究成果,投稿时必须选择所投内容分属的范畴,主要包括以下几个方面的内容:A 基础电化学(包括谱学电化学和电催化);B-I 锂离子电池(正极材料,包括锂硫电池和锂空电池);B-II 锂离子电池(负极、电解液和系统等);C 燃料电池;D 其他电池及超级电容器;E 有机、环境与工业电化学(有机电合成,电解、电镀、金属腐蚀与防护、电沉积和表面处理技术等);F 纳米与材料电化学(纳米电化学、功能材料电化学等);G 电分析化学和生物电化学(包括电化学传感器等);H 光电化学(包括无机、有机光电材料与器件等)。

2、论文格式要求及投稿方式参阅会议网站:<http://17cse.suda.edu.cn/>。

学术报告

1、大会邀请报告(排名不分先后,具体报告议程将在第三轮通知确定)

田中群院士(厦门大学) 刘忠范院士(北京大学)

李述汤院士(苏州大学) 李 灿院士(大连化物所)

Prof. Matsue(日本东北大学)

Prof. Jacek Lipkowski(加拿大院士)

本届中国电化学贡献奖获得者(1)

本届中国电化学贡献奖获得者(2)

2、分会报告与墙报

征集的论文将由大会学术委员会和各分会负责人拟定邀请报告、口头报告和墙报(投稿人在投稿时明确意向),口头报告和墙报具有同等的学术地位。

电化学专题讲座培训班(培训地点:苏州大学;培训时间:2013年11月15日 8:30~17:00)

1. 微电极 多孔电极 粉末微电极……陆君涛(教授)/武汉大学

2. 交流阻抗技术与应用……张鉴清(教授)/浙江大学

3. 电化学中的原位光谱技术……任 斌(教授)/厦门大学

4. 电化学论文写作与投稿……章宗穰(教授)/上海师范大学

会议注册

1、会议注册费

2013年9月10日(含)前(注册)缴费:一般代表每位RMB 1500元,学生代表每位RMB 1200元;企业代表每位:RMB 2200元。2013年9月10日后及会议期间缴费:一般代表每位RMB 1700元,学生代表每位RMB 1400元(凭有效学生证件);企业代表每位:RMB 2400元。

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企业赞助或其它事宜通过电话或邮件与会议联系人联系。

第十七次全国电化学大会组委会

苏州大学能源学院(代章)

2013年4月22日