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KINETIC PARAMETERS OF THE ELECTRODE REACTION: $2\,Cl^- \rightleftarrows Cl_2 + 2e^-$

(Technical Report)

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Kinetic parameters of the electrode reaction: $2\ Cl^- \rightleftarrows Cl_2 + 2e^-$

Abstract - Kinetic parameters of the electrode reaction, $2\ Cl^- \rightleftarrows Cl_2 + 2\ e^-$, at various electrodes and in various electrolytes are compiled and tabulated.

INTRODUCTION

A large amount of data concerning the kinetic parameters characterizing the charge transfer process of a variety of electrode reactions have been published in the literature. A compilation of such data on charge transfer processes of metallic species was made by Tanaka and Tamamushi (ref. 1, 2).

In this document the compilation of the kinetic parameters of the electrode reaction, $2\ Cl^- \rightleftarrows Cl_2 + 2\ e^-$, at various electrodes and in various electrolytes is presented, covering up to the year 1989. The chlorine evolution reaction is one of the most important and interesting reactions in electrochemistry, both from the practical viewpoint of electrochemical technology and from the fundamental viewpoint of electrocatalysis. Detailed discussions of the mechanisms of this reaction can be found in the comprehensive reviews by Mussini and Faita (ref. 3), by Novak, Tilak and Conway (ref. 4) and by Trasatti (ref. 5).

The data were extracted from the data bank at Electrochemical Data Center, Yokohama National University. The data are tabulated as much as possible in the form they are reported in the literature. However, for detailed information on a particular system, the original paper should be consulted because, as is well-known, electrochemical kinetic parameters often depend not only on the electrode material but on the conditions of electrode preparation. General definitions and explanations of electrochemical kinetic parameters are given in ref. 2 and refs. 6-8.

GENERAL REMARKS CONCERNING THE TABLE

1. General arrangement and presentation of the parameters: The following table summarizes the kinetic parameters of the electrode reaction at electrodes of various materials in various electrolytes. Electrode materials are arranged in alphabetical order according to their atomic symbols.

2. Electrode: The first column presents the material and composition of the working electrode and the second gives the preparation and/or electrode treatment. When the same procedure is used for different electrode materials, a symbol *Pn (n=1,2,...) is used in place of a full description of the procedure. The place where the full description is given is indicated in the last column.

3. Medium: The third column gives the composition of the solution and, when available, the practical pressure of chlorine gas above the solution. Unless otherwise noted, the solutions are aqueous. Note that M is used as the unit of concentration instead of mol/dm^3. Pressure is given in atm if it is used in the original literature. ($1\ M = 1\ mol/dm^3$ and $1\ atm = 1.01325 \times 10^5\ Pa$).

4. Temperature: This column gives the temperature in ℃ .

5. **Transfer coefficient and/or Tafel slope:** The anodic (α_a) and cathodic (α_c) transfer coefficients are given in the fifth and sixth columns respectively. The slopes of Tafel plots for an anodic and cathodic branches (b_a and b_c) are often quoted in place of the transfer coefficients.

6. **Rate constant or exchange current density:** The symbol k^o represents the standard heterogeneous rate constant (also named conditional electrode reaction rate constant). More frequently than k^o the values of the exchange current density j_o are reported.
Finally, where available, the potential dependent rate constant, k_{ox}, at a specified potential is also tabulated. Numerical values in this column are often given in the form aEb rather than $a\times 10^b$; e.g., 2.0E-3 should be read as 2.0×10^{-3}.

7. **Energy of activation:** The eighth column gives the energy of activation for the indicated condition.

8. **Method:** The method for measuring the electrochemical kinetic parameters is shown in this column using the abbreviation given in the LIST OF SYMBOLS AND ABBREVIATIONS.

9. **Note:** Numbers in this column indicate footnotes. The symbol *F indicates that the parameter(s) were taken or calculated from a figure in the original literature.

10. **Stoichiometric numbers and reaction orders:** When these values are reported in the original literature, then are cited in the footnotes.

LIST OF SYMBOLS AND ABBREVIATIONS

Symbols

A	surface area of the electrode
b_a	anodic Tafel slope
b_c	cathodic Tafel slope
E	electrode potential
E_{eq}	equilibrium potential
F	Faraday constant
j	current density
j_o	exchange current density
k^o	conditional electrode reaction rate constant
k_{ox}	electrode reaction rate constant for oxidation
n_a	number of charge transferred in the rate determining step
$n_a(Cl_2)$	anodic reaction order in Cl_2
$n_a(Cl^-)$	anodic reaction order in Cl^-
$n_c(Cl_2)$	cathodic reaction order in Cl_2
$n_c(Cl^-)$	cathodic reaction order in Cl^-
$p(Cl_2)$	partial pressure of chlorine
R	gas constant
T	thermodynamic temperature
α_a	anodic transfer coefficient
α_c	cathodic transfer coefficient
η	overpotential
ν	stoichiometric number

Abbreviations

chp	chronopotentiometry
cp	current-potential curve
fi	faradaic impedance method
gs	galvanostatic method
gsdp	galvanostatic double pulse method
lsv	linear sweep voltammetry
pd	potentiodynamic method
ps	potentiostatic method
RDE	rotating disk electrode
SCE	saturated calomel electrode
SHE	standard hydrogen electrode

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TABLE 1. Kinetic parameters of the reaction $2Cl^- = Cl_2 + 2e^-$

Electrode: Material	Electrode: Preparation and/or treatment method	Medium	Temperature /°C	Transfer coefficient or Tafel slope: anodic	Transfer coefficient or Tafel slope: cathodic	Rate constant or exchange current density	Energy of activation	Method	Reference	Note
Ag plated on Pt	(A=0.63cm^2)	0.05M HCl + 1M H_2SO_4	25	α_a=0.69 (n_a=1)	α_c=0.28 (n_a=1)	k°=1.26E-3 cm/s		cp	9	
graphite	RDE (A=0.95cm^2), embedded in Teflon sleeve, preelectrolysis at 50 mA/cm^2 for 1h	saturated NaCl, pH ca. 0.5, $p(Cl_2) \approx$ 1atm	50	b_a=120mV (at high cd) b_a=40mV (at low cd)	b_c=-120mV	j_0=1.2E-3 A/cm^2		cp-RDE	10	1)
graphite	RDE (A=0.713cm^2), polished with waterproof Al_2O_3 paper and fine paper	37% $ZnCl_2$, pH 3.29, $[Cl_2]$=1.17 g/dm^3	25	b_a=124mV	b_c=-120mV b_c=-39.7 mV at low cd	j_0=1.11E-3 A/cm^2		cp-RDE	11	2)
		37% $ZnCl_2$, pH 3.29, $[Cl_2]$=1.23 g/dm^3	25			k=1.16E-2 cm/s at E=310mV vs. SCE k=6.76E-3 cm/s at E=410mV vs. SCE				
graphite		1M H_2SO_4 + 0.05M HCl	25	α_a=0.44	α_c=0.45	k°=1.74E-3 cm/s		ps	12	
graphite	powder(10-15wt%) and binder were mixed, compressed into a disk, heated in air at 240°C for 30-40 min, soaked in 1% polystylene soln. in benzene, heated at ca. 100°C (*P1)	5M NaCl, Cl_2 bubbled		b_a=2.3 × 2RT/3F				cp-gs	13	*P1
graphite	new graphite	4M NaCl + 1M HCl	25	b_a=127mV α_a=0.46		j_0=2.52E-4 A/cm^2		cp-gs	14	3)
			14.5	b_a=151mV α_a=0.38		j_0=2.35E-4 A/cm^2				
			30	b_a=123mV α_a=0.49		j_0=2.46E-4 A/cm^2				

Electrode		Medium	Temp./°C	Transfer coefficient	Rate constant	Energy of activation	Method	Ref.	Note
graphite	new graphite	4M NaCl + 1M HCl	40	b_a=102mV α_a=0.61	j_0=2.70E-4 A/cm^2		cp-gs	14	
			50	b_a=127mV α_a=0.63	j_0=2.66E-4 A/cm^2				
vitreous carbon		5M NaCl, pH ca. 3.5 p(Cl_2) ?	95	b_a=1.09 (RT/F)	j_0=3.0E-4 A/cm^2		gs	15	4)
vitreous carbon		5M NaCl, pH ca. 3.5 p(Cl_2) ?	95	b_a=1.64 (RT/F) (cd > 2 mA/cm^2)	j_0=5.0E-4 A/cm^2		gs	15	
graphite	spectroscopically pure, porosity 25%	fused LiCl p(Cl_2)=1 atm	656	b_a=93mV α_a=1.97	j_0=1.3E-1 A/cm^2		gs	16	5)
graphite	porous, porosity 30%	fused LiCl p(Cl_2)=1 atm	656	b_a=90mV α_a=2.04	j_0=1.9E-1 A/cm^2	29.7 kJ/mol for j_0	gs	16	
			714	b_a=93mV α_a=2.10	j_0=2.4E-2 A/cm^2				
			765	b_a=95mV α_a=2.16	j_0=2.8E-2 A/cm^2				
pyrolytic graphite a-direction	basal plane, encapsulated in boron nitride, circular and planar (A=0.3cm^2)	AgCl-NaCl melt	750	b_a=100~107mV	j_0=(1.5, 3.0~4.0)E-2 A/cm^2		cp-gs	17	
					j_0=1.1E0 A/cm^2		gsdp		
pyrolytic graphite b-direction	basal plane, encapsulated in quartz, nitride, circular and planar (A=0.3cm^2)	AgCl-NaCl melt	750	b_a=102~114mV	j_0=(1.7~2.0)E-2 A/cm^2		cp-gs	17	
pyrolytic graphite c-direction	perpendicular to basal plane, encapsulated in boron nitride, planar and circular (A=0.3cm^2)	AgCl-NaCl melt	750	b_a=100~110mV	j_0=(5.0~6.0)E-2 A/cm^2		cp-gs	17	
					j_0=1.9E0 A/cm^2		gsdp		
SPK graphite	encapsulated in boron nitride, planar and circular, polished on a diamond wheel (A=0.3cm^2)	AgCl-NaCl melt	750	b_a=100, 108mV	j_0=1.40E-1 A/cm^2		cp-gs	17	

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
SPK graphite	encapsulated in quartz, hemi-spherical,(A=0.6cm^2)	AgCl-NaCl melt	750	b_a=100~104mV		j_0=(1.0~1.2)E-1 A/cm^2		cp-gs	17	
						j_0=2.0E0 A/cm^2		gsdp		
AGKSP graphite	encapsulated in boron nitride, planar and circular, polished on a diamond wheel, (A=0.3cm^2)	AgCl-NaCl melt	750	b_a=102, 103mV		j_0=2.3E-1 A/cm^2 j_0=2.8E-1 A/cm^2		cp-gs	17	
						j_0=(5.2~5.6)E0 A/cm^2		gsdp		
AGKSPK graphite	encapsulated in quartz,hemispherical, (A=0.6cm^2)	AgCl-NaCl melt	750	b_a=102~104mV		j_0=(1.0~2.0)E-1 A/cm^2		cp-gs	17	
AUC graphite	encapsulated in boron nitride, planar and circular, polished on a diamond wheel (A=0.3cm^2)	AgCl-NaCl melt	750	b_a=112mV		j_0=1.80E-1 A/cm^2		cp-gs	17	
						j_0=3.85E0 A/cm^2		gsdp		
glassy carbon	rod sealed in a Pyrex glass tube, the end being cut off at 45°, polished with alumina powder suspension	NaCl + $AlCl_3$ melt log[a(Cl^-)]=-1.1, p(Cl_2)=1 atm	175	b_a=(85 ±4)mV	b_c=-(115 ±12)mV	j_0=(8.6±0.8)E-6 A/cm^2		cp-ps	18	
vitreous carbon	encapsulated in boron nitride, planar and circular, polished on a diamond wheel (A=0.3cm^2)	AgCl-NaCl melt	750	b_a=100~110mV		j_0=(1.5~2.5)E-2 A/cm^2		cp-gs	17	
						j_0=(0.76~0.9)E0 A/cm^2		gsdp		
vitreous carbon	sealed in quartz, polished end (diameter 0.15cm)	NaCl + KCl melt (NaCl:KCl=3:1 in mass ratio)	820 850 880			j_0=6.63 A/cm^2 j_0=7.15 A/cm^2 j_0=7.92 A/cm^2		fi	19	
		NaCl + KCl + $AlCl_3$ melt (NaCl:KCl=3:1 in mass ratio) ($AlCl_3$ 13 wt%)	790 820 850 880			j_0=5.37 A/cm^2 j_0=5.87 A/cm^2 j_0=6.43 A/cm^2 j_0=6.91 A/cm^2				
		NaCl + KCl + $AlCl_3$ melt (NaCl:KCl=3:1 in mass ratio) ($AlCl_3$ 19 wt%)	790 820 850 880			j_0=4.95 A/cm^2 j_0=5.38 A/cm^2 j_0=5.98 A/cm^2 j_0=6.40 A/cm^2				

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
vitreous carbon	sealed in quartz, polished end (diameter 0.15cm)	NaCl + KCl + $AlCl_3$ melt (NaCl:KCl=3:1 in mass ratio) ($AlCl_3$ 29 wt%)	820 850 880			j_0=4.39 A/cm^2 j_0=4.88 A/cm^2 j_0=5.47 A/cm^2		fi	19	
		NaCl + KCl + $AlCl_3$ melt (NaCl:KCl=3:1 in mass ratio) ($AlCl_3$ 36.5 wt%)	820 850 880			j_0=4.02 A/cm^2 j_0=4.37 A/cm^2 j_0=4.82 A/cm^2				
Co_3O_4 on Ti	thermal decomposition of $Co(NO_3)_2$ applied to Ti plate (1cm^2), fired at 260°C, with RuO_2 interlayer between Co_3O_4 and Ti	1M NaCl + 0.01M HCl pure Cl_2 saturated	25	α_a=0.5 b_a=40mV		j_0=4.8E-3 A/cm^2	(75±4) kJ/mol for Cl_2 evolution at E=1.1V vs. SCE	cp-ps	20	6) *F
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm}=0.0	25	α_a=0.5		j_0=4.5E-3 A cm^{-2}				
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-0.6	25	α_a=0.5		j_0=1.7E-3 A cm^{-2}				
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-1.0	25	α_a=0.5		j_0=1.0E-3 A cm^{-2}				
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-1.5	25	α_a=0.5		j_0=4.8E-4 A cm^{-2}				
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-2.0	25	α_a=0.5		j_0=1.8E-4 A cm^{-2}				
Co_3O_4 on Ti	thermal decomposition of $Co(NO_3)_2$ applied to Ti plate (1 cm^2), fired at 400°C, with RuO_2 interlayer between Co_3O_4 and Ti (*P2)	1M NaCl + 0.01M HCl log{p(Cl_2)/atm}=0.0	25	α_a=0.5		j_0=8.9E-4 A cm^{-2}		cp-ps	20	6) *F *P2
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-0.6	25	α_a=0.5		j_0=4.7E-4 A cm^{-2} =-3.33				
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-1.0	25	α_a=0.5		j_0=2.6E-4 A cm^{-2}				
		1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-1.5	25	α_a=0.5		j_0=1.4E-4 A cm^{-2}				

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Co_3O_4 on Ti	see *P2	1M NaCl + 0.01M HCl log{p(Cl_2)/atm} =-2.0	25	α_a=0.5		j_0=9.1E-5 A cm^{-2}		cp-ps	20	
$Eu_{0.1}WO_3$	see *P1	5M NaCl, Cl_2 bubbled		b_a=2.3 ×2RT/3F		(j_0)=1.9E-5A /100μF		cp-gs	13	7)
Fe_3O_4		5M NaCl, pH ca. 3.5 p(Cl_2) ?	95	b_a=2.3× 0.68RT/F		j_0=5.5E-11 A/cm^2		gs	15	
Ir	wire of 0.5mm in diameter sealed in glass (A=0.13 cm^2)	0.2M HCl + 1M H_2SO_4 p(Cl_2)=1 atm	25			j_0=2.0E-4 A/cm^2		cp-gs	21	8) *F
Ir	cathodic polarization for ca. 5 min at ca. 10 mA/cm^2	5M NaCl, pH ca. 3.5 p(Cl_2) ?	95	b_a=2.3× 0.63RT/F		j_0=6.4E-3 A/cm^2		gs	15	9)
Ir (iridium oxide) on Ti	thermal treatment, 35mg Ir/dm^2 electrode surface, polarization between potentials for hydrogen and oxygen evoltion in 0.5 M H_2SO_4 (*P3)	0.05 M KCl + 0.5 M H_2SO_4 p(Cl_2)= 0.1 atm		b_a=60mV α_a=1		j_0=2.8E-5 A/cm^2		cp-ps	22	10) *P3
		0.1 M KCl + 0.5 M H_2SO_4 p(Cl_2)=0.1 atm		b_a=60mV α_a=1		j_0=4.1E-5 A/cm^2				
		0.5 M KCl + 0.5 M H_2SO_4 p(Cl_2)=0.1 atm		b_a=60mV α_a=1		j_0=4.2E-5 A/cm^2				
		1.0 M KCl + 0.5 M H_2SO_4 p(Cl_2)=0.1 atm		b_a=60mV α_a=1		j_0=3.5E-5 A/cm^2				
Ir (iridium oxide) on Ti	see *P3	1.0 M KCl + 0.5 M H_2SO_4 p(Cl_2)=0.02∼0.2atm			b_c=-220mV α_c=0.26			cp-ps	22	
IrO_2	see *P1	5M NaCl, Cl_2 bubbled		b_a=2.3 ×2RT/3F		(j_0)=3.9E-4A /100μF		cp-gs	13	7)
$LaNiO_3$	see *P1	5M NaCl, Cl_2 bubbled		b_a=2.3 ×2RT/2F		(j_0)=1.44E-4A /100μF		cp-gs	13	7)
$La_{0.6}Sr_{0.4}CoO_3$	see *P1	5M NaCl, Cl_2 bubbled		b_a=2.3 ×RT/2F		(j_0)=4.33E-4A /100μF		cp-gs	13	7)

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
MnO_2 on Pt		5M NaCl, Cl_2 bubbled		b_a=2.3 ×RT/2F		(j_0)=4.10E-4A /100μF		cp-gs	13	7)
MnO_2 doped with Ir (2 atomic %)	thermal decomposition of solution of $Mn(NO_3)_2$, metal salts and HCl at 160-180°C, resulting oxide being thermally treated at 450°C for 20 h, polished with emery paper to a tablet shape (*P4)	3 M NaCl + 0.5 M H_2SO_4 p(Cl_2)=1 atm	30	b_a=57mV		j_0=3.8E-2 A/cm^2		fi	23	*P4
MnO_2 doped with Pd (2 atomic %)	see *P4	3 M NaCl + 0.5 M H_2SO_4 p(Cl_2)=1 atm	30	b_a=33mV		j_0=6.1E-2 A/cm^2		fi	23	
MnO_2 doped with Ru (2 atomic %) atomic %)	see *P4	3 M NaCl + 0.5 M H_2SO_4 p(Cl_2)=1 atm	30	b_a=55mV		j_0=4.1E-2 A/cm^2		cp-gs	23	
MnO_2 doped with Pt 2 atomic %)	see *P4	3M NaCl + 0.5 M H_2SO_4 p(Cl_2)=1 atm	30	b_a=45mV		j_0=6.8E-2 A/cm^2		cp-gs	23	
MnO_2 (Pd doped, 2 and 5 atomic %) (Pd 0.2%) (Pd 0.5%) (Pd 1%) (Pd 2%) (Pd 5%)	Aqueous solution of $Mn(NO_3)_2$ and $PdCl_2$ was dried, thermally decomposed in air at 160-180°Cand at 450°C for 16h	3 M NaCl + 1 M $HClO_4$		b_a=30mV			for Cl_2 evolution at constant potential 31.9 kJ/mol 26.8 kJ/mol 29.3 kJ/mol 57.3 kJ/mol 66.9 kJ/mol	cp-gs	24	
PbO_2 on Ta	prepared by anodic oxidation of aqueous Pb^{2+} solution(A=1cm^2)	0.5 M NaCl		α_a=0.174		j_0=8E-6 A/cm^2		cp-ps	25	
		2.0 M NaCl		α_a=0.27		j_0=4.0E-7 A/cm^2				
Pt	wire of 0.5mm in diameter sealed in glass (A=0.05cm^2)	0.2M HCl + 1M H_2SO_4 p(Cl_2)=1 atm	25			j_0=3.7E-3 A/cm^2		cp-gs	21	11) *F

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Pt	polished with emery paper, immersed in conc. NaOH and conc. HCl solutions ($A=1cm^2$) (*P5)	1M NaCl + 2M $NaClO_4$ Cl_2 saturated				j_0=5.5E-4 A/cm^2		cp-gs	26	*P5
Pt	cathodic polarization for ca. 5 min at ca. 10 mA/cm^2	5M NaCl, pH ca. 3.5 $p(Cl_2)$?	95	$b_a=2.3\times$ 0.60RT/F		j_0=8.5E-3 A/cm^2		gs	15	12)
Pt	RDE in a glass tube ($A=0.785mm^2$)	0.012 M HCl + 2.2 M $HClO_4$	25		α_c=0.69	j_0=5.7E-3 A/cm^2		cp-RDE	27	13)
Pt	RDE in a glass tube ($A=0.785mm^2$)	0.021 M HCl 2.2 M $HClO_4$	25		α_c=0.69	j_0=8.0E-3 A/cm^2		cp-RDE	27	
Pt	RDE in a glass tube ($A=0.785mm^2$)	0.037 M HCl + 2.2 M $HClO_4$	25		α_c=0.69	j_0=13E-3 A/cm^2		cp-RDE	27	
Pt	RDE in a glass tube ($A=0.785mm^2$)	0.063 M HCl + 2.2 M $HClO_4$	25		α_c=0.69	j_0=16E-3 A/cm^2		cp-RDE	27	
Pt	wire	1M H_2SO_4 + HCl ([HCl]=0.1, 0.05, 0.02 M)	25	$\alpha_a n_a$ =0.72	$\alpha_c n_a$ =0.27	$k°$=1.13E-3 cm/s		ps	28	
Pt	wire	1M H_2SO_4 + HCl ([HCl]=0.01, 0.005 M)	25	$\alpha_a n_a$ =0.4		$k°$=9.5E-4 cm/s		ps	28	
Pt	shielded electrode	0.1M HCl + 1M H_2SO_4	25	$\alpha_a n_a$ =0.41		k=1.54E-13 cm/s at E=0.0V vs. NHE k=1.73E-1 cm/s at E=1.436V vs. NHE		chp	29	
Pt	shielded electrode	0.2M HCl + 1M H_2SO_4	25	$\alpha_a n_a$ =0.41		k=0.97E-13 cm/s at E=0.0V vs. NHE k=1.73E-1 cm/s at E=1.465V vs. NHE		chp	29	
Pt	mounted in a glass holder ($A=4.4cm^2$)	0.5 M NaCl		α_a=0.205		j_0=1.85E-3 A/cm^2		cp-ps	25	
		2.0 M NaCl		α_a=0.400		j_0=4.45E-3 A/cm^2				
Pt	smooth	3M NaCl + 0.5 M H_2SO_4 $p(Cl_2)$=1 atm	30	b_a=33mV		j_0=6.7E-3 A/cm^2		cp-gs	23	

Electrode		Medium	Temp./°C	Transfer coefficient	Rate constant	Energy of activation	Method	Ref.	Note
Pt	wire sealded in a glass tube, activated by repeated anodic and cathodic polarization (A=0.025cm^2)	5M NaCl pH 1, Cl_2 saturated	30	$\alpha_a n_a$ =0.5	j_0=7E-2 A/cm^2	12.6 kJ/mol for j_0	cp-lsv	30	
			50	$\alpha_a n_a$ =0.5	j_0=1E-1 A/cm^2				
			70	$\alpha_a n_a$ =0.5	j_0=1.4E-1 A/cm^2				
			90	$\alpha_a n_a$ =0.5	j_0=1.8E-1 A/cm^2				
Pt		0.5M H_2SO_4 + 0.01M~0.1M HCl	25	b_a=110mV			cp-gs	31	
Pt (oxygen covered Pt, PtO)	bright foil spot-welded to a Pt wire sealed in a pyrex glass tube (A=0.3cm^2) (*P6)	2M NaCl pH 2.0	25	b_a=300mV	j_0=1E-3 A/cm^2		cp-lps	32	*P6
			65	b_a=330mV	j_0=3.5E-3 A/cm^2				
			85	b_a=275mV	j_0=5.0E-4 A/cm^2				
Pt (oxygen covered Pt, PtO_2 and PtO)	see *P6	2M NaCl pH 2.0	25	b_a=250mV	j_0=5.0E-5 A/cm^2		cp-lps	32	14a)
			25	b_a=280mV	j_0=8.0E-5 A/cm^2				14b)
			25	b_a=305mV	j_0=1.1E-4 A/cm^2				14c)
			25	b_a=315mV	j_0=1.1E-4 A/cm^2				14d)
			25	b_a=290mV	j_0=6.3E-5 A/cm^2				14e)
			25	b_a=290mV	j_0=6.3E-5 A/cm^2				14f)
Pt (oxygen covered Pt, PtO_2 and PtO)	see *P6	2M NaCl pH 2.0	65	b_a=300mV	j_0=5.3E-4 A/cm^2		cp-lps	32	14a)
			65	b_a=260mV	j_0=2.0E-4 A/cm^2				14b)
			65	b_a=285mV	j_0=2.0E-4 A/cm^2				14c)
			65	b_a=250mV	j_0=1.0E-4 A/cm^2				14d)
			65	b_a=250mV	j_0=1.2E-4 A/cm^2				14e)
			65	b_a=250mV	j_0=1.0E-4 A/cm^2				14f)
Pt (oxygen covered Pt, PtO_2 and PtO)	see *P6	2M NaCl pH 2.0	85	b_a=260mV	j_0=8.0E-5 A/cm^2		cp-lps	32	14a)
			85	b_a=240mV	j_0=2.0E-4 A/cm^2				14b)
			85	b_a=250mV	j_0=2.75E-4 A/cm^2				14c)
			85	b_a=260mV	j_0=2.0E-4 A/cm^2				14d)
			85	b_a=250mV	j_0=2.0E-4 A/cm^2				14e)
			85	b_a=250mV	j_0=2.0E-4 A/cm^2				14f)
Pt (oxygen covered Pt, PtO_2 and PtO)	see *P6	5M NaCl pH 2.0	25	b_a=360mV	j_0=2.6E-3 A/cm^2		cp-lps	32	14a)
			25	b_a=390mV	j_0=1.55E-3 A/cm^2				14b)
			25	b_a=345mV	j_0=5.0E-4 A/cm^2				14c)
			25	b_a=305mV	j_0=2.0E-4 A/cm^2				14d)
			25	b_a=305mV	j_0=2.0E-4 A/cm^2				14e)
			25	b_a=310mV	j_0=9.0E-5 A/cm^2				14f)

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Pt	RDE	0.1M KCl + 0.05M H_2SO_4 $p(Cl_2)$=0.026 atm	25	α_a=0.37	b_c=-160mV	j_0=2.8E-4 A/cm^2		cp-RDE	33	15) *F
Pt	RDE	0.1M KCl + 0.05M H_2SO_4 $p(Cl_2)$=0.052 atm	25	α_a=0.37	b_c=-160mV	j_0=5.2E-4 A/cm^2		cp-RDE	33	15) *F
Pt	RDE	0.1M KCl + 0.05M H_2SO_4 $p(Cl_2)$=0.085 atm	25	α_a=0.37	b_c=-160mV	j_0=6.4E-4 A/cm^2		cp-RDE	33	15) *F
Pt	RDE	0.1M KCl + 0.05M H_2SO_4 $p(Cl_2)$=0.16 atm	25	α_a=0.20	b_c=-290mV	j_0=1.1E-3 A/cm^2		cp-RDE	33	15) *F
Pt	RDE	0.1M KCl + 0.05M H_2SO_4 $p(Cl_2)$=0.093atm	25		α_c=0.72	j_0=1.1E-3 A/cm^2		cp-RDE	33	15) *F
Pt	RDE	0.2M KCl + 0.05M H_2SO_4 $p(Cl_2)$=0.093atm	25		α_c=0.72	j_0=1.23E-3 A/cm^2		cp-RDE	33	15) *F
Pt	RDE	0.5M KCl + 0.5M H_2SO_4 $p(Cl_2)$=0.093atm	25		α_c=0.72	j_0=1.5E-3 A/cm^2		cp-RDE	33	15) *F
Pt	RDE	1M KCl + 0.5M H_2SO_4 $p(Cl_2)$=0.093atm	25		α_c=0.72	j_0=2.0E-3 A/cm^2		cp-RDE	33	15) *F
Pt (unpassivated)	spherical button formed by melting in oxygen flame and mounted in a Pyrex tube, cathodically polarized at 0.5 A/cm^2 for 5 min (*P7)	1M HCl 2M HCl 3M HCl 4M HCl 5M HCl 6M HCl 7M HCl 8M HCl		α_a=0.53 α_a=0.52 α_a=0.55 α_a=0.64 α_a=0.62 α_a=0.45 α_a=0.59 α_a=0.40		j_0=4.8E-3 A/cm^2 j_0=9.6E-3 A/cm^2 j_0=5.3E-3 A/cm^2 j_0=3.1E-3 A/cm^2 j_0=1.4E-2 A/cm^2 j_0=3.8E-2 A/cm^2 j_0=2.6E-2 A/cm^2 j_0=2.4E-2 A/cm^2		cp-gs	34	*P7
		1M NaCl 2M NaCl 3M NaCl 4M NaCl 5M NaCl		α_a=0.49 α_a=0.65 α_a=0.58 α_a=0.66 α_a=0.66		j_0=6.7E-4 A/cm^2 j_0=1.66E-3 A/cm^2 j_0=3.9E-4 A/cm^2 j_0=6.4E-4 A/cm^2 j_0=7.4E-4 A/cm^2				

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Pt (unpassivated)	see *P7	2M HCl + 3M NaCl		α_a=0.74		j_0=5.63E-3 A/cm^2		cp-gs	34	
Pt (passivated)	see *P7	1M HCl 2M HCl 3M HCl 4M HCl 5M HCl 6M HCl 7M HCl 8M HCl		α_a=0.07 α_a=0.07 α_a=0.07 α_a=0.074 α_a=0.05 α_a=0.06 α_a=0.06 α_a=0.04		j_0=1.7E-3 A/cm^2 j_0=1.7E-3 A/cm^2 j_0=1.8E-3 A/cm^2 j_0=1.5E-3 A/cm^2 j_0=2.2E-2 A/cm^2 j_0=4.9E-2 A/cm^2 j_0=8.6E-2 A/cm^2 j_0=2.7E-1 A/cm^2		cp-gs	34	
Pt (passivated)	see *P7	1M NaCl 2M NaCl 3M NaCl 4M NaCl 5M NaCl		α_a=0.15 α_a=0.13 α_a=0.12 α_a=0.12 α_a=0.14		j_0=8.0E-6 A/cm^2 j_0=3.2E-6 A/cm^2 j_0=2.0E-5 A/cm^2 j_0=1.6E-5 A/cm^2 j_0=7.1E-6 A/cm^2		cp-gs	34	
Pt (passivated)	see *P7	2M HCl + 3M NaCl		α_a=0.039		j_0=6.3E-2 A/cm^2		cp-gs	34	
PtO_2 on Ti		5M NaCl, Cl_2 bubbled		b_a=2.3 × RT/2F		(j_0)=5.50E-4A /100μF		cp-gs	13	7)
Pt on Ti	Pt was electrochemically plated on Ti, Pt layer thickness 30 μm	0.02M NaCl + 1M $NaClO_4$, 1.00% Cl_2	30		b_c=−0.2V (|η|< 0.2V) b_c=−0.4∼ −0.5V (|η|> 0.25V)	j_0=4.6E-4 A/cm^2		cp-ps	35	16)
Pt on Ti	Pt was electrochemically plated on Ti, Pt layer thickness 30 μm	0.02M NaCl + 1M $NaClO_4$, 1.00% Cl_2	30	b_a=0.12V (η<0.2V) b_a=0.6V (η>0.4V)		j_0=0.6E-3 A/cm^2		cp-ps	35	17)
Pt plated on Ti		1M H_2SO_4 + 0.05M HCl	25	α_a=0.74	α_c=0.27	k°=1.28E-3 cm/s		cp-ps	12	
Pt plated on Ta		1M H_2SO_4 + 0.05M HCl	25	α_a=0.73	α_c=0.27	k°=1.10E-3 cm/s		cp-ps	12	
Pt		[Cl^-]=4.1mM, [Cl_2]=14.4mM, 0.4M $LiClO_4$ in AN	0	b_a=(106 ±20)mV	b_c=−(115 ±20)mV	j_0=(1.2±0.3)E-4 A/cm^2		cp-RDE	36	18)

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Pt		$[Cl^-]$=6.2mM, $[Cl_2]$=16.0mM, 0.4M $LiClO_4$ in AN	0	b_a=(111 ±20)mV	b_c=−(102 ±20)mV	j_0=(1.36±0.3)E-4 A/cm^2		cp-RDE	36	19)
Pt		$[Cl^-]$=8.4mM, $[Cl_2]$=10.1mM, 0.4M $LiClO_4$ in AN	0	b_a=(115 ±20)mV	b_c=−(92 ±20)mV	j_0=(1.07±0.3)E-4 A/cm^2		cp-RDE	36	20)
Pt		$[Cl^-]$=8.5mM, $[Cl_2]$=23.9mM, 0.4M $LiClO_4$ in AN	0	b_a=(101 ±20)mV	b_c=−(101 ±20)mV	j_0=(1.53±0.3)E-4 A/cm^2		cp-RDE	36	
Pt		$[Cl^-]$=9.3mM, $[Cl_2]$=26.8mM, 0.4M $LiClO_4$ in AN	0	b_a=(100 ±20)mV	b_c=−(96 ±20)mV	j_0=(1.80±0.3)E-4 A/cm^2		cp-RDE	36	21)
Pt		$[Cl^-]$=9.3mM, $[Cl_2]$=7.0mM, 0.4M $LiClO_4$ in AN	0	b_a=(112 ±20)mV	b_c=−(97 ±20)mV	j_0=(1.08±0.3)E-4 A/cm^2		cp-RDE	36	22)
Pt		$[Cl^-]$=9.8mM, $[Cl_2]$=10.4mM, 0.4M $LiClO_4$ in AN	0	b_a=(98 ±20)mV	b_c=−(90 ±20)mV	j_0=(1.77±0.3)E-4 A/cm^2		cp-RDE	36	23)
Pt		$[Cl^-]$=10.6mM, $[Cl_2]$=15.9mM, 0.4M $LiClO_4$ in AN	0	b_a=(113 ±20)mV	b_c=−(97 ±20)mV	j_0=(1.33±0.3)E-4 A/cm^2		cp-RDE	36	24)
Pt		$[Cl^-]$=11.3mM, $[Cl_2]$=11.4mM, 0.4M $LiClO_4$ in AN	0	b_a=(125 ±20)mV	b_c=−(105 ±20)mV	j_0=(1.70±0.3)E-4 A/cm^2		cp-RDE	36	25)
Pt		$[Cl^-]$=11.4mM, $[Cl_2]$=17.6mM, 0.4M $LiClO_4$ in AN	0	b_a=(107 ±20)mV	b_c=−(115 ±20)mV	j_0=(2.20±0.3)E-4 A/cm^2		cp-RDE	36	26)
Pt		$[Cl^-]$=12.1mM, $[Cl_2]$=9.5mM, 0.4M $LiClO_4$ in AN	0	b_a=(113 ±20)mV	b_c=−(98 ±20)mV	j_0=(1.05±0.3)E-4 A/cm^2		cp-RDE	36	27)
Pt		$[Cl^-]$=13.8mM, $[Cl_2]$=13.7mM, 0.4M $LiClO_4$ in AN	0	b_a=(119 ±20)mV	b_c=−(105 ±20)mV	j_0=(1.54±0.3)E-4 A/cm^2		cp-RDE	36	28)

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Pt		$[Cl^-]$=15.1mM, $[Cl_2]$=21.5mM, 0.4M $LiClO_4$ in AN	0	b_a=(105 ± 20)mV	b_c=−(94 ± 20)mV	j_0=(2.30±0.3)E-4 A/cm^2		cp-RDE	36	29)
Pt		$[Cl^-]$=15.8mM, $[Cl_2]$=8.1mM, 0.4M $LiClO_4$ in AN	0	b_a=(114 ± 20)mV	b_c=−(118 ± 20)mV	j_0=(2.33±0.3)E-4 A/cm^2		cp-RDE	36	
Pt		$[Cl^-]$=17.8mM, $[Cl_2]$=6.6mM, 0.4M $LiClO_4$ in AN	0	b_a=(100 ± 20)mV	b_c=−(127 ± 20)mV	j_0=(1.45±0.3)E-4 A/cm^2		cp-RDE	36	
Pt		$[Cl^-]$=26.8mM, $[Cl_2]$=11.6mM, 0.4M $LiClO_4$ in AN	0	b_a=(124 ± 20)mV	b_c=−(100 ± 20)mV	j_0=(2.63±0.3)E-4 A/cm^2		cp-RDE	36	30)
Pt		$[Cl^-]$=4.8mM 0.4M $LiClO_4$ in AN	0	b_a=(153 ± 20)mV		j_0=(7.0±0.6)E-5 A/cm^2		cp-RDE	36	31)
Pt		$[Cl^-]$=7.8mM 0.4M $LiClO_4$ in AN	0	b_a=(165 ± 20)mV		j_0=(8.0±0.6)E-5 A/cm^2		cp-RDE	36	
Pt		$[Cl^-]$=10.6mM 0.4M $LiClO_4$ in AN	0	b_a=(165 ± 20)mV		j_0=(1.1±0.6)E-4 A/cm^2		cp-RDE	36	32)
Pt		$[Cl^-]$=15.2mM 0.4M $LiClO_4$ in AN	0	b_a=(157 ± 20)mV		j_0=(9.0±0.6)E-5 A/cm^2		cp-RDE	36	33)
Pt		$[Cl^-]$=18.9mM 0.4M $LiClO_4$ in AN	0	b_a=(150 ± 20)mV		j_0=(1.0±0.6)E-4 A/cm^2		cp-RDE	36	34)
Pt		$[Cl_2]$=9.7mM 0.4M $LiClO_4$ in AN	0		b_c=−(133 ± 20)mV	j_0=(2.20±0.6)E-4 A/cm^2		cp-RDE	36	35)
Pt		$[Cl_2]$=21.3mM 0.4M $LiClO_4$ in AN	0		b_c=−(130 ± 20)mV	j_0=(4.00±0.6)E-4 A/cm^2		cp-RDE	36	36)
Pt	(A=0.227cm^2)	0.416∼6.34M HCl + 0.1M TEAP in DMSO	25	α_a=0.52		k^o=1.0E-2 cm s^{-1}		chp	37	
Pt/Ir(10.1%) alloy	see *P5	1M NaCl + 2M $NaClO_4$ Cl_2 saturated				j_0=5.5E-4 A/cm^2		cp-gs	26	
Pt/Ir(15.2%) alloy	see *P5	1M NaCl + 2M $NaClO_4$ Cl_2 saturated				j_0=4.9E-4 A/cm^2		cp-gs	26	

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Pt/Ir on Ti (Ir 0, 0.5, 2, 4 and 100%)	polarized for 10s alternatively at 1.7V and -0.4V for 10 times and held at -0.4V for 3s	0.1M NaCl 1M NaCl saturated NaCl	30 30 30	b_a=30mV b_a=30mV b_a=30mV				gs-ps-RDE	38	
Pt/Ir (30% Ir) alloy on Ti	Painted with mixture of $PtCl_5$, $IrCl_4$ etc., dried and heated at 500°C for 1h, cooled in water. 1 mg/cm^2 of Pt+Ir as chloride	0.02M NaCl + 1M $NaClO_4$, 1.00% Cl_2	30		b_c=-0.18V ($\|\eta\|$< 0.2V)	j_0=2.0E-3 A/cm^2		cp-ps	35	37)
		0.02M NaCl + 1M $NaClO_4$, 1.00% Cl_2	30	b_a=0.15~0.2V (η <0.2V) b_a=0.6V (η >0.4V)		j_0=2.5E-3 A/cm^2		cp-ps	35	38)
Pt/Ir (70:30)	thermally formed, cathodic polarization for ca. 5min at ca. 10 mA/cm^2	5M NaCl, pH ca. 3.5 p(Cl_2) ?	95	b_a=2.3 × (0.27 ~0.34) × (RT/F)		j_0=3.75E-3 A/cm^2		gs	15	39)
Pt/Ir (70:30)	smooth surface, cathodic polarization for ca. 5min at ca. 10 mA/cm^2	5M NaCl, pH ca. 3.5 p(Cl_2) ?	95	b_a=2.3 ×0.71 (RT/F)		j_0=8.5E-4 A/cm^2		gs	15	40)
Pt/Pd(17.0%) alloy	see *P5	1M NaCl + 2M $NaClO_4$ Cl_2 saturated				j_0=4.0E-4 A/cm^2		cp-gs	26	
Pt/Pd(24.0%) alloy	see *P5	1M NaCl + 2M $NaClO_4$ Cl_2 saturated				j_0=4.0E-4 A/cm^2		cp-gs	26	
Pt/Rh(32.4%) alloy	see *P5	1M NaCl + 2M $NaClO_4$ Cl_2 saturated				j_0=4.3E-4 A/cm^2		cp-gs	26	
Pt/Ru(17.0%) alloy	see *P5	1M NaCl + 2M $NaClO_4$ Cl_2 saturated				j_0=4.5E-4 A/cm^2		cp-gs	26	
Rh	wire of 0.5mm in diameter sealed in glass (A=0.06cm^2)	0.2M HCl + 1M H_2SO_4 p(Cl_2)=1 atm	25			j_0=4.0E-5 A/cm^2		cp-gs	21	41) *F
Rh	cathodic polarization for ca. 5min at ca. 10 mA/cm^2	5M NaCl, pH ca. 3.5 p(Cl_2) ?	95	b_a=2.3 ×0.74 (RT/F)		j_0=5.9E-3 A/cm^2		gs	15	42)
Ru	disk (A=1.00 cm^2)	4M NaCl + 1M HCl Cl_2 saturated	25	b_a=40mV		j_0=1.3E-4 A/cm^2		cp-pd	39	*F

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
Ru	cathodic polarization for ca. 5min at ca. 10 mA/cm^2	5M NaCl, pH ca. 3.5 $p(Cl_2)$?	95	b_a=2.3 ×(0.27 ～0.38) ×(RT/F)		j_0=2E-4 A/cm^2		gs	15	43)
RuO_2(30mol%)/ TiO_2(70mol%) on Ti	Painted with aq. soln. of $TiCl_3$, $RuCl_3$ etc., dried and fired at 500°C for 1h	4M NaCl + 1M HCl Cl_2 saturated	25	b_a=40mV α_a=0.55 ±0.05		j_0=13E-5 A/cm^2	27.2 kJ/mol for cd at η=60mV and 2～70°C	cp-pd	39	
RuO_2(10%)/TiO_2 (90%) on Ti	Painted with mixture of $RuCl_3$, butyl titanate and butyl alcohol,dried by heating up to 130°C and decomposed thermally	1M HCl + 1M H_2SO_4	40	b_a=34 ±0.5mV		j_0=6.7E-5 A/cm^2 (a=-142mV)	43.3～44.6 kJ/mol for cd at η:70～100mV	cp-gs	40	
			80	b_a=34 ±0.5mV		j_0=5.1E-4 A/cm^2 (a=-112mV)				
			40 50 60 80			j_0=2.8E-4 A/cm^2 j_0=4.5E-4 A/cm^2 j_0=7.4E-4 A/cm^2 j_0=1.8E-3 A/cm^2				*F
RuO_2/TiO_2 on Ti (RuO_2 1～100%)	thermal decomposition of Ti and Ru salts deposited on Ti base	300g/dm^3 NaCl		b_a=20 ～30mV				cp-gs	41	
RuO_2 (100%)		1.5M HCl + 2.5M NaCl, $p(Cl_2)$=1 atm	30	b_a=40mV	b_c=-120mV	j_0=1.4E-3 A/cm^2		cp-gs	42	*F
RuO_2 (100%)		1.5M HCl + 2.5M NaCl, $p(Cl_2)$=0.0568atm	30	b_a=40mV	b_c=-120mV	j_0=1.6E-4 A/cm^2		cp-gs	42	*F
RuO_2 on Ti	coated with 6 coats of 0.4M $RuCl_3$ in propanol and fired at 400°C for 1～50 h	5M NaCl, Cl_2 saturated	20	b_a=95mV		j_0=6.3E-3 A cm^{-2}		cp-gs	43	
RuO_2 on Ti	coated with 2,4,6,8 coats of 0.4M $RuCl_3$ in propanol and fired at 400°C for 1～50h	5M NaCl, Cl_2 saturated	20	b_a=(108 ±12)mV		j_0=3.9E-2 A cm^{-2}		cp-gs	43	
RuO_2/TiO_2 on Ti (RuO_2 1mol%)	coated with solution of $RuCl_3$ in propanol and anhydrous $TiCl_4$, $Ti(OEt_4)$ in propanol and fired in air at 400°C for 5min and then for 6h (*P8)	5M NaCl, Cl_2 saturated	20			j_0=4.0E-5 A cm^{-2}		cp-gs	43	*P8 *F
			60			j_0=2.0E-4 A cm^{-2}				

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
RuO_2/TiO_2 on Ti (RuO_2 5mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=8.9E-5 A cm^{-2}		cp-gs	43	*F
			60			j_0=2.0E-4 A cm^{-2}				
RuO_2/TiO_2 on Ti (RuO_2 10mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=1.0E-3～2.5E-4 A cm^{-2}		cp-gs	43	*F
			60			j_0=1.0E-2/A cm^{-2}				
RuO_2/TiO_2 on Ti (RuO_2 20mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=1.0E-3～2.5E-4 A cm^{-2}		cp-gs	43	*F
RuO_2/TiO_2 on Ti (RuO_2 25mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=4.5E-3 A cm^{-2}		cp-gs	43	*F
			60			j_0=4.0E-3 A cm^{-2}				
RuO_2/TiO_2 on Ti (RuO_2 30mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=4.5E-3 A cm^{-2}		cp-gs	43	*F
RuO_2/TiO_2 on Ti (RuO_2 40mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=7.9E-3～6.3E-3 A cm^{-2}		cp-gs	43	*F
RuO_2/TiO_2 on Ti (RuO_2 50mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=7.9-3E～5.0E-3 A cm^{-2}		cp-gs	43	*F
			60			j_0=5.6E-3 A cm^{-2}				
RuO_2/TiO_2 on Ti (RuO_2 60mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=6.3E-3～5.6E-3 A cm^{-2}		cp-gs	43	*F
RuO_2/TiO_2 on Ti (RuO_2 70mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=7.1E-3～5.6E-3 A cm^{-2}		cp-gs	43	*F
RuO_2/TiO_2 on Ti (RuO_2 80mol%)	see *P8	5M NaCl, Cl_2 saturated	20			j_0=7.1E-3 A cm^{-2}		cp-gs	43	*F

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
RuO_2/TiO_2 on Ti		5M NaCl, pH ca. 3.5 $p(Cl_2)$?	95	b_a=2.3 ×0.38 (RT/F)		j_0=1.25E-3 A/cm^2		gs	15	44)
RuO_2(35%)/TiO_2 on Ti	square plate (2×2×0.1 cm), exposed area is 0.05cm^2	1M HCl				k°=2.7E-8 cm/s		fi	44	
RuO_2	see *P1	5M NaCl, Cl_2 bubbled		b_a=2.3× 2RT/3F		(j_0)=1.18E-4A /100μF		cp-gs	13	7)
RuO_2/TiO_2 on Ti (2% Ru)	thermal decomposition of $RuCl_3$ and $TiCl_4$	4M NaCl $p(Cl_2)$=1E-3atm	25			j_0=7E-6 A/cm^2		cp-ps	45	
RuO_2/TiO_2 on Ti (30% Ru)	thermal decomposition of $RuCl_3$ and $TiCl_4$	4M NaCl $p(Cl_2)$=1E-3atm	25			j_0=6E-6 A/cm^2		cp-ps	45	
RuO_2(30mol%)/ TiO_2(70mol%) on Ti	(A=0.282cm^2)	1.5M HCl + 2.5M NaCl $p(Cl_2)$=1 atm	30		b_c=-(82 ±1)mV α_c=0.73	j_0=2.45E-4 A cm^{-2}		cp-ps	46	45)
RuO_2(30mol%)/ TiO_2(70mol%) on Ti	(A=0.282cm^2)	1.5M HCl + 2.5M NaCl $p(Cl_2)$=0.0266 atm	30		b_c=-(68 ±2)mV α_c=0.88	j_0=5.5E-6A cm^{-2}		cp-ps	46	46)
RuO_2(30%)/TiO_2	0.03g Ru/m^2, temperature of lining 420°C	1.5M HCl + 2.5M NaCl, $p(Cl_2)$=1 atm	 60 45 30 15	b_a=30 mV		anodic j_0=3.4E-4 A cm^{-2} j_0=2.5E-4 A cm^{-2} j_0=1.8E-4 A cm^{-2} j_0=5.4E-5 A cm^{-2}	~16.7 kJ/mol for j_0	cp-gs	47	*F
RuO_2(30%)/TiO_2	0.03g Ru/m^2, temperature of lining 420°C	1.5M HCl + 2.5M NaCl, $p(Cl_2)$=1 atm	 60 45 30			cathodic j_0=2.95E-4 A cm^{-2} j_0=1.82E-4 A cm^{-2} j_0=1.05E-4 A cm^{-2}	~33.5 kJ/mol for j_0	cp-gs	47	

Electrode		Medium	Temp./°C	Transfer coefficient		Rate constant	Energy of activation	Method	Ref.	Note
RuO_2 on Sb-doped SnO_2	RuO_2 layer was prepared by heating $RuCl_3$ layer applied to SnO_2 film on a Pyrex plate at 500°C for 20 min, the procedure being repeated 20 times. slightly polished with alumina powder, degreased with NaOH methanol soln., washed with conc. HCl and H_2SO_4, and water and dried at 120°C for 12h.	NaCl + $AlCl_3$ melt log[a(Cl^-)]=-1.1, p(Cl_2)=1 atm	175	b_a=(72 ±8) mV	b_c=-(105 ±8) mV	j_0=(1.32±0.22) E-4 A/cm^2		cp-ps	48	47)

1) ν=1 (ca. 1.2), $n_a(Cl^-)$=1 (ca. 0.6), $n_a(Cl_2)$=0, $n_c(Cl^-)$=0 and $n_c(Cl_2)$=1. **2)** ν=1.2, $n_c(Cl_2)$=0.6 or 0.74. **3)** α_a=0.5 and j_0=(0.009±0.002)E-3 A/cm^2 (real surface area) for Heyrovsky reaction, j_0=(0.18±0.04)E-3 A/cm^2 (real surface area) for Volmer reaction at 25°C and in 4M NaCl + 1M HCl solution. **4)** ν=1.18. **5)** $\nu\approx$0.5, probably ν=1. **6)** $\nu\approx$1. For η=const., $n_a(Cl^-)=1-2\alpha$, $n_a(Cl_2)=\alpha$, $n_a(H^+)$=-1 and $\alpha\approx$0.5. For E = const., $n_a(Cl_2)$=0, $n_c(Cl^-)$=0 and $n_a(H^+)$=-1. **7)** j_0 is expressed in the value per the fixed differential capacity (100μF); thus being denoted as (j_0). **8)** ν=1. For E - E_{eq} < -120 mV, $n_a(Cl^-)$=2, $n_a(Cl_2)$=0, $n_c(Cl^-)$=0 and $n_c(Cl_2)$=1. For E-E_{eq} > 150 mV, $n_a(Cl^-)$=1, $n_a(Cl_2)$=0, $n_c(Cl^-)$=-1 and $n_c(Cl_2)$=1. **9)** ν=1.08. **10)** ν=1.8, 1.7, 2.4, 1.8: and average is 2. $n_a(Cl_2)$=0, $n_c(Cl^-)$=1. **11)** For E > E_{eq}, ν=2, $n_a(Cl^-)$=1, $n_a(Cl_2)$=0, $n_c(Cl^-)$=0 and $n_c(Cl_2)$=0.5. For E-E_{eq} < -100 mV, ν=1, $n_a(Cl^-)$=2, $n_a(Cl_2)$=0, $n_c(Cl^-)$=0 and $n_c(Cl_2)$=1. **12)** ν=1.1. **13)** $n_c(Cl_2)$=1. **14)** Potential sweep were carried out once in a) 1 min, b) 2 min, c) 5 min, d) 10 min, e) 20 min and f) 50 min. **15)** ν=2. For p(Cl_2) > 0.1 atm, $n_c(Cl^-)$=0, and $n_c(Cl_2)$=0.5. For p(Cl_2) < 0.1 atm, $n_c(Cl^-)$=0 and $n_c(Cl_2)$=1. **16)** ν=2.3 (cathodic), $n_c(Cl^-)$=0 and $n_c(Cl_2)$=1. **17)** ν=1.9 (anodic), and $n_a(Cl_2)$=0. **18)** $n_a(Cl^-)$=0.93 and $n_c(Cl_2)$=1.07. **19)** ν=1.35 (anodic), ν=1.17 (cathodic) and $n_a(Cl^-)$=1.03. **20)** $n_a(Cl^-)$=0.91 and $n_c(Cl_2)$=1.00. **21)** $n_a(Cl^-)$=1.02. **22)** ν=0.95 (anodic) and ν=0.95 (cathodic). **23)** ν=1.05 (anodic), ν=1.15 (cathodic) and $n_c(Cl_2)$=0.95. **24)** ν=1.26 (anodic), ν=1.07 (cathodic) and $n_a(Cl^-)$=1.05. **25)** $n_a(Cl^-)$=0.99 and $n_c(Cl_2)$=1.05. **26)** $n_c(Cl_2)$=1.12. **27)** $n_a(Cl^-)$=1.11 and $n_c(Cl_2)$=0.90. **28)** $n_c(Cl_2)$=0.98. **29)** ν=1.19 (anodic), ν=0.88 (cathodic), $n_a(Cl^-)$=1.02, and $n_c(Cl_2)$=0.95. **30)** ν=1.15 (anodic), ν=0.87 (cathodic), $n_a(Cl^-)$=1.03 and $n_c(Cl_2)$=0.91. **31)** $n_a(Cl^-)$=1.05. **32)** $n_a(Cl^-)$=0.92. **33)** $n_a(Cl^-)$=0.98. **34)** $n_a(Cl^-)$=1.06. **35)** $n_c(Cl_2)$=1.14. **36)** $n_c(Cl_2)$=0.90. **37)** ν=2.0 (cathodic), $n_c(Cl^-)$=0, and $n_c(Cl_2)$=0.5 for η<0.2 V and $n_c(Cl_2)$=1 for η>0.2 V. **38)** ν=2.0 (anodic) and $n_a(Cl_2)$=0. **39)** ν=0.89. **40)** ν=1.02. **41)** For E - E_{eq} < -150 mV, $\nu\approx$1, $n_c(Cl^-)$=0, $n_c(Cl_2)$=1. $n_a(Cl^-)$=2 and $n_a(Cl_2)\approx$0. For E > E_{eq}, $n_a(Cl_2)$=0, and $n_a(Cl^-)$=1. **42)** ν=1.08. **43)** ν=0.14. **44)** ν=0.91. **45)** ν=0.95 (anodic) and ν=0.06 (cathodic). **46)** ν=0.81 (anodic) and ν=0.21 (cathodic). **47)** ν=0.94.

*F: Parameters were taken or calculated from a figure in the literature.

*P1~*P8: Some electrodes were prepared or pre-treated in the same manner. In order to avoid a repeated description, these symbols are used.

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