Description and parameters of electrochemical experiments

MATERIALS AND METHODS

Experimental setup and materials

A rotating disc electrode (RDE) system and a Potentiostat (PGU-OEM-Mi 10V-2A) obtained by the IPS Elektroniklabor GmbH & Co KG (Münster) was used for the electrochemical investigations.

The RDEs were made using an inlay of pure zinc (99.99 % supplied by IPS see above) with a surface area of 1 cm^2. The zinc surface was first cleaned and degreased by rinsing with water and with isopropanol (p.a.) and later grinded and polished using abrasive grinding paper (SiC paper with 600 grit and later 2400 grit).

The cell was constructed as heatable (by thermostat) double-walled glass vessel (500 cm^3) with different openings and connections (corrosion measuring cell KMZ 5 by Sensortechnik Meinsberg).

The reference electrode (Ag/AgCl) was used with an intermediate vessel as Haber Lugging Capillary, whereas the counter electrode was realized by an electrically connected platinum foil at the bottom of the cell.

Cyclic polarization beginning from the open circuit potential up to -200 mV (cathodic polarisation) and later up to +400 mV (anodic polarization) was realized using the equipment described above.

Electrolyte (500 ml):

Solutions of boric acid (Optibor HP (high purity) / Caldic deutschland chemie b.v.) with 1000 - 3000 ppm boron in deionized water with 0.1 M sodium sulfate (p.a. / VWR) as conducting salt was used as electrolyte. In some experiments, an addition of LiOH (p.a.; supplied by VWR) to adjust the pH value as used.

Standard solution: boric acid solution with 2000 ppm boron + 0.2ppm lithium (as LiOH) and 0.1 M Na_2SO_4 (as conductive salt) ; pH 5.4

All deviations from this standard electrolyte composition are described in table 1 below (column 3 from the left).

Basic parameters of conducted electrochemical experiments

Experiment	T_{Fluid} / °C	Electrolyte	f [rpm]	v / mV/s	E (mV) vs. Ag/AgCl
EC_V003	23 °C	Standard (s.o.)	0	1	-1250 / + 850
EC_V004	23 °C	Standard (s.o.)	120	0.5	-1100 / -900
EC_V005	23 °C	Standard (s.o.)	480	0.5	-1200 / -900
EC_V006 a - e	28 °C	Standard (s.o.)	0 (a) 120 (b) 240 (c) 480 (d) 960 (e)	0.5	-1230 / -830
EC_V007 a - f	30 °C	Standard (s.o.)	0 (a) 120 (b) 240 (c) 480 (d) 960 (e) 1920 (f)	1	-1230 / -830
EC_V008 a - e	30 °C	Standard, but 1 ppm Li as LiOH (pH 5.66)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1200 / -850
EC_V009 a - e	30 °C	Standard, but 5 ppm Li as LiOH (pH 5.94)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1200 / -850
EC_V010	30 °C	Standard (s.o.)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1200 / -850
EC_V011	30 °C	Standard, but without lithium (0 ppm Li as LiOH; pH 4.65)	0 (a) 480 (b) 960 (c) 1920 (d)	1	-1200 / -850
EC_V012	20 °C	Standard, but without lithium (0 ppm Li as LiOH; pH 4.65)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1200 / -850
EC_V013	45 °C	Standard, but without lithium (0 ppm Li as LiOH; pH 4.65)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1220 / -820
EC_V014	60 °C	Standard, but without lithium	0 (a)	1	-1220 / -820

		(0 ppm Li as LiOH; pH 4.65)	480 (b)		
EC_V015	30 °C	Standard, but with 20 ppm Li as LiOH; pH 6.92)	0 (a) 480 (b) 960 (c) 1920 (d)	1	-1220 / -820
EC_V016	30 °C	Standard, but with 50 ppm Li as LiOH; pH 7.32)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1220 / -820
EC_V017	30 °C	Boric acid with1000 ppm boron and without lithium; pH 6.13)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1220 / -820
EC_V018	30 °C	0.1 M Na_2SO_4 Without boric acid without lithium; pH 7.0)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1220 / -820
EC_V019	30 °C	Boric acid with1500 ppm boron and without lithium; pH 6.13)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1220 / -820
EC_V020	30 °C	Boric acid with 3000 ppm boron and without lithium; pH 4.72)	0 (a) 240 (b) 480 (c) 960 (d) 1920 (e)	1	-1220 / -820
EC_V021	60 °C	Standard, but without lithium (0 ppm Li as LiOH; pH 4.65)	0 (a) 480 (b) 1920 (c)	1	-1220 / -820
EC_V022	50 °C	Standard (s.o.)	0 (a) 480 (b) 960 (c)	1	-1230 / -830
EC_V023	50 °C	Standard (s.o.)	0 (a) 960 (b)	1	-1230 / -830
EC_V025	30 °C	Standard, without (a / b) und with Phosphate [0.01 M Na_2HPO_4]; (c / d)	0 (a) 480 (b) P_0 (c) P_480 (d)	1	-1230 / -830
EC_V026	30 °C	Standard (s.o.), but deaerated with N2-Spülung	0 (a) 120 (b) 240 (c) 480 (d) 960 (e)	1	-1230 / -800

		(0.02-0.06 mg/l O_2 or 0.3 – 0.8 % O_2)	1920 (f)		

f = rotating speed of the rotating disc electrode [rpm = rounds per minute]

v = speed rate of the linearly changed electrode potential (mV/s)

E(mv) = Potential range of the working electrode during cyclic polarisation in relation to the reference electrode Ag/AgCl and with a platinum counter electrode

The data files of this experiments have the same name, but as text files with the ending xxx.asc . The left column in this text files give the values of the electric current in mA and the next column give the values of the corresponding potential of the working electrode in mV (vs. Ag/AgCl as reference electrode).

Allocation of the measurement files (see above) to the figures of the planned paper

Figure number	Description	Associated measurement files
Fig. 1	Dependency of current density on temperature of the electrolyte without rotation (ω = 0) and with infinite high rotation speed of the RDE (Levich extrapolation ω to infinite)	EC_V012 EC_V007 EC_V013 EC_V021
Fig. 2	Cathodic and anodic polarization curves with the rotating disc electrode (zinc) under variation of the angular frequency ω (T = 30 °C)	EC_V007 (a – f)
Fig. 3	Dependency of calculated zinc corrosion rates υ on flow conditions (rotation speed)	EC_V007 (a – f)
Fig. 4	Comparison of two similar polarization experiments, with aerated or deaerated (by insertion of nitrogen) electrolyte	EC_V007e EC_V026e