1st South East European Congress of Chemical Engineering

organized by:
Association of Chemical Engineers, Serbia and Montenegro
Hellenic Association of Chemical Engineers, Greece
Hungarian Chemical Society, Hungary
Society of Chemists and Technologists of Macedonia, FYROM
Bulgarian Society of Chemical Engineering, Bulgaria
Romanian Society of Chemical Engineering, Romania

BOOK OF ABSTRACTS

Faculty of Technology and Metallurgy
Belgrade, Serbia and Montenegro
September 25-28, 2005
www.ache.org.yu/SEECChE1/

CIP – каталогизација у публикацији
Народна библиотека Србије, Београд

66(048)

SOUTH East European Congress of Chemical Engineering (1st ; Beograd)
Book of Abstract / 1st South East European Congress of Chemical Engineering – SEECChE 1, Belgrade, September 25-28, 2005 ; organized by Association of Chemical Engineers ... [et al.] ; [editors Dejan Skala, Željko Grbavčić, Aleksandar Dekanski]. – Belgrade : Association of Chemical Engineers, 2005 (Belgrade : Department of Graphical Engineering, Faculty of Technology and Metallurgy). – XXVI, 297 str. : ilustr. ; 25 cm

Tiraž 300. – Str. VIII-IX: Preface /Dejan Skala. Napomene i bibliografske reference uz tekst. – Bibliografija uz pojedine radove. – Registar.

ISBN 86-905111-0-5
1. Skala, Dejan
a) Хемијске технологије – Библиографије, реферативне
COBISS.SR-ID 125255436

1st South East European Congress of Chemical Engineering
BOOK OF ABSTRACTS

Published by:
Association of Chemical Engineers
Kneza Miloša 9/I, 11000 Belgrade, Serbia and Montenegro
Tel/fax: + 381 11 3240 018; www.ache.org.yu; e-mail: shi@yubc.net

For the Publisher:
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Editors:
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Paging and graphical design:
Dr. *Aleksandar* ***Dekanski***

ISBN 86-905111-0-5

Circulation: **300 copies**

Printed and bound by:
Department of Graphical Engineering
Faculty of Technology and Metallurgy
Karnegijeva 4, Belgrade, SCG, tel. +381 11 33 70 492, e-mail: gt@tmf.bg.ac.yu

Barrier Properties of Anodically Formed Nb_2O_5

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By cyclic voltammetry and ellipsometry the barrier properties of Nb_2O_5, anodically formed on Nb electrode, in various concentrations of acid and alkaline solutions, have been investigated. The cyclic voltammetry I-E profiles reveal to the active/passive transition, i.e. metal dissolution and then, formation of thin passive film. Upon reversing the potential scan, the current decreases abruptly until it reaches almost of constant value that is several orders of magnitude lower than the first forward scan. This behavior can be considered to be the result of high current efficiency under oxide growth. In active region metal dissolution occurs by reaction

$$Nb \rightarrow Nb^{5+} + 5e^-$$

while in the passive region the large current plateau, (Fig.1), is provoked by film thickness grows following the reaction.

$$2Nb + 5H_2O \rightarrow Nb_2O_5 + 10H^+ + e^-$$

The barrier properties of anodically formed Nb_2O_5 in the passive region can most easily interrelated by performing of sequence of cyclic voltammetry measurements in which the final potential is gradually enlarged in each next cycle, Fig.2

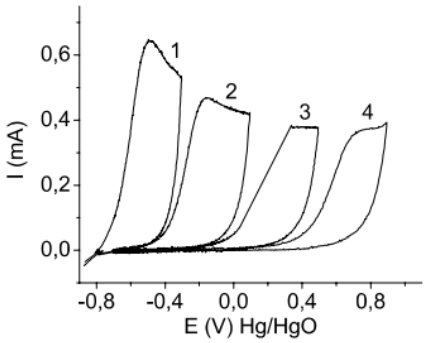

Fig 1. Voltammograms of Nb electrode recorded in 1 M KOH: 1 – first cycle, 2 – second cycle(v = 50 mV/s)

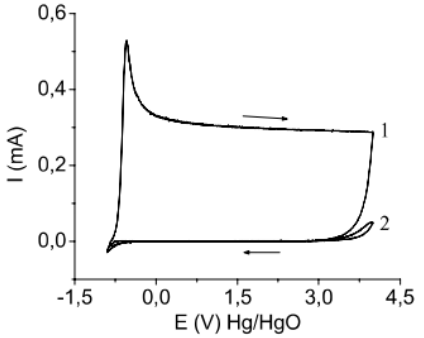

Fig. 2. Voltammograms of Nb electrode recorded in 1 M KOH: 1, 2, 3 and 4 are number of cycles (v = 50 mV/s)

In fig.2, the anodic oxidation may take place only if the actual potential exceeds the maximum value attained in the previous cycle. The large current plateau almost parallel with E axis indicates linear grows of film thickness with applied potential.

The ellipsometric measurements have shown the linear film thickness grows with applied voltage, even at 100 V, indicating barrier properties not only for thin, but also and for thick film. The coefficient of film thickness growth is approximately 2.3 nm/V