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A new advance in the study of p-type silicon/electrolyte interface by electrochemical impedance spectroscopy

Mouna Hecini · Abdellah Khelifa · Baya Palahouane · Salaheddine Aoudj · Houria Hamitouche

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Abstract For comprehensive interpretation of the electrochemical processes occurring at silicon/electrolyte interfaces, the purpose of this work was to use electrochemical impedance measurements (EIS) to characterize silicon/electrolyte interfaces in the dark and to record the physical, electrical, and chemical processes during the different steps of silicon dissolution in hydrofluoric (HF) acid solution. In this study we used two main electrochemical techniques—potentiodynamic polarization and EIS under different bias potentials. The in-situ current–voltage $I(V)$ characteristic clearly identifies the pore formation (porous silicon), transition, and electropolishing regions. Two series of impedance diagrams were recorded in the potential range in which the depletion layer was generated within the semiconductor substrate and in the range of potentials corresponding to the onset of an accumulation layer. Our results show that the impedance of silicon/electrolyte interfaces depends on the surface roughness and porosity of the substrate. At a particular positive value of the bias, an important induction loop was observed in addition to the usual capacitive behavior. It is highly significant that, for finite pore length, mass transfer and pore geometry might lead to different impedance curves. An electrical equivalent circuit model was used to fit the best experimental data to the theoretical data.

Keywords Porous silicon · Interface kinetics · Electrical equivalent circuit · Impedance · Inductive loop

M. Hecini (✉) · B. Palahouane · S. Aoudj
Centre de Recherche en Technologie des Semi-conducteurs Pour l'Energétique, CRTSE. 02, Bd Frantz Fanon. BP 140, Alger-7-merveilles, 16200 Algiers, Algeria
e-mail: hecinimouna@yahoo.fr

M. Hecini · A. Khelifa · H. Hamitouche
Laboratoire de Génie Chimique, Département de Chimie Industrielle, Faculté de Technologie, Université Saâd Dahlab, USDB. BP 270, Route de Soumâa, 09000 Blida, Algeria

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