Analytical Surface Potential Model for Columnar Nanocrystalline Silicon Thin Film Transistors

Riad Remmouche, Rachid Fates, Hachemi Bouridah
Electronics Department, Jijel University
remmouche@yahoo.com, rachid.fates@yahoo.fr, hachemi.bouridah@gmail.com

Abstract

An analytical model to calculate the nano-crystalline silicon (nc-Si) ultra-thin film transistors (UTFT) surface potential is proposed. This pattern is based on an ultra- thin channel with a columnar morphology. Our approach is based on the charge trapping at the grain boundary, the well- defined charge distribution into the inversion layer and the consideration of quantum size effects on dielectric constant and band gap. Results denote that, the surface potential is associated to the silicon crystallites size and geometry. The comparison of our results with existing research model shows a good agreement between the surface potential shapes and an interesting difference in the surface potential variation, caused essentially by the morphology considered. The research in this area is more condensed on the current-voltage relationships, so several authors have made a considerable study concerning the surface potential for poly-Si TFTs. However, few researches have focused on the study of the nc-Si TFTs electrical characteristics. L.F. Mao has studied the impact of quantum size effects on the dielectric constant and the band gap on the surface potential of nc-Si TFTs, without considering the channel morphology. Experimental researches have been accomplished on ultra-thin silicon films in order to determine the crystallites shape. It has been clearly determined that the crystallites morphology is columnar, i.e. the columns were formed parallel to the growth direction. The purpose of this work is to propose a new approach in order to define the surface potential analytical calculation by considering a columnar crystallites structure, defined by an accurate crystallites size and geometry.

References

1. "T. Anutgan and M. Anutgan and I. Atilgan and B. Katircioglu". "Capacitance analyses of hydrogenated nanocrystalline silicon based thin film transistor". "Thin Solid Films, 519 (2011) 3914-3921".
2. "A. Kuo and T.K. Won and J. Kanicki". "Back channel etch chemistry of advanced a-Si:H TFTs". "Microelectron. Eng. 88 (2011) 207-212".
3. "W. Deng and J. Huang". "A physics-based approximation for the polysilicon thin-film transistor surface potential". "IEEE Electr. Device L. 32 (2011) 647-649".
4. "L.F. Mao". "The quantum size effects on the surface potential of nanocrystalline silicon thin film transistors" . "Thin Solid Films 518 (2010) 3396-3401".
5. "W. Deng and J. Huang and X. Li". "Surface-potential-based drain current model of polysilicon TFTs with gaussian and exponential dos distribution". "IEEE T. Electron. Dev. 59 (2012) 94-100".