「エレクトロニクス実装学会誌」12〔3〕208～220 (2009)

論文

ドリフト拡散デバイスシミュレーションを用いた実装応力に起因するnMOSFETのDC特性変動評価手法

小金丸　正明*，池田　徹**，宮崎　則幸**，友景　肇***

An Evaluation Method for DC Characteristics Shifts in Resin-Molded nMOSFETs Using Drift-Diffusion Device Simulation

Masaaki KOGANEMARU*, Toru IKEDA**, Noriyuki MIYAZAKI** and Hajime TOMOKAGE***

*福岡県工業技術センター機械電子研究所（〒807-0831　福岡県北九州市八幡西区則松3-6-1）
**京都大学大学院工学研究科（〒606-8501　京都府京都市左京区吉田本町）
***福岡大学工学部電子情報工学科（〒814-0180　福岡県福岡市城南区七隈8-19-1）
*Mechanics & Electronics Research Institute, Fukuoka Industrial Technology Center (3-6-1 Norimatsu, Yahatanishi-ku, Kitakyushu-shi, Fukuoka 807-0831)
**Department of Mechanical Engineering and Science, Graduate School of Engineering, Kyoto University (Yoshida-Honmachi, Sakyo-ku, Kyoto-shi, Kyoto 606-8501)
***Department of Electronics Engineering and Computer Science, Fukuoka University (8-19-1 Nanakuma, Jonan-ku, Fukuoka-shi, Fukuoka 814-0180)

概要　実装応力に起因するnMOSFETのDC特性変動を，ドリフト拡散デバイスシミュレーションにより評価する手法を検討した。応力効果をデバイスシミュレーション上で取り扱うための電子移動度モデルを検討し，実験結果との比較からその妥当性を検証した。この移動度モデルでは，応力によるSi伝導帯エネルギ変化，および伝導帯エネルギ変化によって引き起こされる電子存在確率と散乱確率の変化を考慮した。このシミュレーション手法を用いて，QFP樹脂封止にともなうnMOSFETのDC特性変動を評価した。その結果，実験で得られたドレイン電流の変動，しきい値電圧の挙動および相互コンダクタンスの変動を再現することができた。

Abstract

The electronic performance of semiconductor devices is adversely affected by residual stress during various packaging processes. Very few attempts have been made to develop a simulation method for evaluating this issue. Therefore, we have verified a device simulation method for evaluating stress-induced effects on the DC characteristics of nMOSFETs. Our simulation model includes an electron mobility model that takes the stress effects into consideration. In the electron mobility model, two physical phenomena induced by stress were modeled: the change in the occupancy of electrons in the conduction band and the change in the average electron relaxation time. We evaluated the variation in the DC characteristics of nMOSFET during an actual resin-molding process (QFP process) using the developed device simulation method, and compared the simulation results with experimental results. Our findings show that the simulation method produced a reasonable approximation of the experimental results. It was demonstrated that the simulation is useful for evaluating stress-induced effects on the DC characteristics of nMOSFETs.

Key Words: *Residual Stress, nMOSFET, DC Characteristics, Electron Mobility, Device Simulation*