複晶矽薄膜電晶體在高電場效應下之電性分析與模型建立

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中文摘要

在此論文中，我們研究了多晶矽電晶體中的電流扭結現象並且建立了從漏電區，次臨界區，線性區到飽和區等一系列的模型。首先，從利用不同製程的薄膜條件和操作環境，我們發現倍增率和臨界能量與薄膜品質是強相關。因此，我們考慮缺限的分佈來修正了臨界能量，並將它導入我們所推導出已經包含了汲極致使能障下降效應的導通區電流。至於缺限分佈, 我們乃是用計算所得與實際量測的活化能比較所得。接著，一個可以正確表達急速導通現象的物理模型被發展出。考慮缺限相關的表面位能和寄生BJT效應，基板電壓可被正確的模擬。最後，我們將一經驗電場代入SRH產生-復合關係式中，並且考慮缺限態之分佈，可以得到一新的漏電流模型。此模型可以大量減少人造參數並給予正確的物理概念。

Analysis and modeling of the high electric field effect in polycrystalline silicon TFTs

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Abstract

In this thesis, we investigated the current kink phenomenon in polysilicon thin-film transistors and built a series of models from turn-off, subthreshold, linear to the saturation regime. Firstly, through utilizing the samples from different process and operation condition we find that the multiplication factor and threshold energy are strongly related to the film quality (or trap density). Therefore, we modified the threshold energy by the trap state distribution and combined it into our above threshold current model which already includes the drain induced barrier lowering effect. As to the trap state distribution was obtained from a computer minimization method that is based on field-effect conductance measurements. Secondly, a physically based numerical simulation that accurately models the abruptly switch-on behavior of n-type poly-Silicon thin-film transistor (TFT) has been developed. Considering both the trap dependent surface electrostatic potential model and the parasitic BJT effect correlated with floating body potential, the abnormal subthreshold swing at high drain bias in short channel devices can be modeled successfully. Based on this model, body voltage can be raised even by the diffusion current under lower gate bias. Finally, the new leakage current model of Poly-Si thin-film transistor had been proposed. We introduced an empirical electrical field and the defect state distribution in the traditional leakage current model which is based on SRH generation-recombination model. This model could reduce fitting parameters dramatically and enhance the insight of physics.

Acknowledgment

研究所這二年走下來雖然辛苦，可是當結束畢業口試那一刹那，回想這些日子來所學到的東西與成長，突然心中揚起來一股無以名之的喜悅，這一路走來總覺得自己是幸運的，在人生的路上有兩位開明的父母，允許我自由的做任何我想做的事，也很高興遇到一位很棒的老師，冉曉雯老師讓我了解到，必須將自己的眼光再放遠一點，未來的路才能走得長久，且在我遇到困難的時候能適時的給予幫助，使論文進度不致停頓。同時也遇到一群好伙伴，清大的世青學長在實驗與理論上都給了我很大的啓發與幫助，以及實驗室的國錫學長對研究的熱情與專業令人敬佩，當然還有一群陪我一同奮鬥的同學們兆仟、士欽、中良、銘龍、德章、政偉和士強，有了你們友情的陪伴，使我在研究的路上不是孤獨的一個人;幸運的，因爲有了你們大家，我才能在這生命舞台一直盡情地揮灑自已，演出最好的一面。

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