低溫複晶矽薄膜電晶體在閘極交流
訊號下之可靠度研究

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摘要

在本篇論文中，我們使用準分子雷射製作低溫複晶矽薄膜電晶體來做可靠度測試，ｐ型和ｎ型低溫複晶矽薄膜電晶體在不同的交流電壓操作區域下的不穩定性被深入的探討，交流電壓的操作區域分成兩部分，一區是開啟區域、一區是關閉區域，開啟區域是指當脈衝振盪高於臨界電壓，此時通道產生；關閉區域是指當脈衝振盪低於臨界電壓，此時通道空乏。在本論文中，元件退化意指低溫複晶矽薄膜電晶體在偏壓過後，電性參數上產生變異情形。我們的量測系統可以同時提供直流和交流電壓訊號的量測，用以分析和探討在不同的交流電壓參數之下，低溫複晶矽薄膜電晶體在開啟和關閉區域所產生退化現象與機制。

不論頻率的高低與否，ｐ型低溫複晶矽薄膜電晶體在關閉區交流偏壓下所產生的退化情形較開啟區嚴重，除此之外，我們也發現在關閉區交流偏壓下，元件特性的退化會隨訊號頻率變動，而在開啟區交流偏壓下，元件特性的退化幾乎與施加訊號的頻率無關。在關閉區交流偏壓下，元件的退化會隨著頻率的增加、峰值電壓的增加和脈衝上升

時間的縮短而益加嚴重。藉由比較電性隨時間的退化情形，我們發現在和交流關閉區域偏壓下的退化機制與直流強飽和偏壓下的退化機制相似，此退化機制為有效通道縮短效應。

不像p型低溫複晶矽薄膜電晶體，我們發現只有當施加的頻率較高(約100千赫茲)時，n型低溫複晶矽薄膜電晶體在關閉區交流偏壓下所產生的退化情形才會較開啟區嚴重。而在較低頻時，可觀察到相反的結果。此現象歸因於在閘極負偏壓下所產生的有效通道縮短效應，此機制藉由電性量測和元件模擬來進行詳細的分析。我們發現在較低的閘極交流訊號下，有效通道縮小效應是其不穩定性的主要來源，雖然由交流偏壓所產生的熱載子效應也隨著同時發生。

Study on the Reliability of Low-Temperature Polycrystalline Silicon Thin Film Transistors under AC Gate Bias Stress

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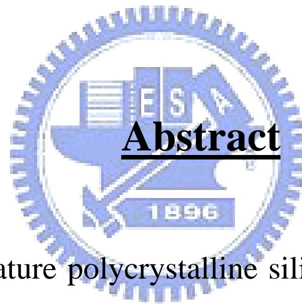

Abstract

In this thesis, low-temperature polycrystalline silicon thin film transistors (LTPS TFTs) were fabricated by excimer laser crystallization for reliability testing. The instabilities of p- and n-channel LTPS TFTs stressed at different AC bias regions were discussed in detail. The AC operating region was divided into ON region and OFF region. The ON region means pulse swing over threshold voltage where the channel region was formed. The OFF region means pulse swing under threshold voltage where the channel region was fully depleted. The device degradation in our work means the variation of electrical parameters in LTPS TFTs after stress. Our measurement system can support the AC and DC signal to do bias stress and measurement. We used this system to study the degradation phenomena and mechanism under ON and OFF region with different AC signal parameters.

The result shows that the degradation of p-channel LTPS TFTs under OFF region stress was much severer than that under ON region no matter the frequency is high or not. Besides,

the degradation of poly-Si TFTs shows frequency dependence under OFF region stress, but is almost constant under ON region stress. Under OFF region stress, the degradation is enhanced by the increase in frequency and/or peak voltage and the decrease in rising time. By means of comparison of the degraded electrical parameters with stress time, the AC OFF region stress has the similar instability mechanism as the DC strong saturation current one. The instability mechanism is effective short channel effect.

Unlike p-channel LTPS TFTs, it was found that the degradation of n-channel LTPS TFTs under OFF region stress was severer than that under ON region only when the frequency is higher (about 100kHz). Reverse situation can be observed under lower frequencies. The phenomenon can be ascribed to the effective short channel effect under accumulation-mode stress. The mechanism was analyzed by electrical measurement and device simulation. The result shows that the effective short channel effect dominates at low AC frequency gate bias stress although hot-carrier effect also occurs simultaneously under the AC gate bias stresses of the turning-off period.