主動式顯示器用複晶矽薄膜電晶體補償電路之研究

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摘　要

複晶矽薄膜電晶體(poly-Si TFT)最近幾年在液晶顯示器(AMLCD)及有機發光二極體(AMOLED)顯示器應用中之所以會是眾所注目的焦點，是因為其優異的元件特性。相較於非晶矽薄膜電晶體，複晶矽薄膜電晶體有較高電流驅動能力及較好的可靠度, 因此在複晶矽薄膜電晶體顯示器裡，它可以被用來整合畫素電路及週邊驅動電路於同一片玻璃基板上，如此使面板結構簡單化且可以減少週邊半導體零組件的使用數量以及後段模組在組裝時的接點數目，進而提高工程可靠度，除此之外更可降低驅動 IC 成本，維持低耗電特性，提供高精細的畫質表現。所以，複晶矽薄膜電晶體被視為實現系統化面板(System on Panel)的關鍵技術。然而，由於複晶矽層不規則的晶粒邊界分佈，複晶矽薄膜電晶體有較差的均勻性，同時元件參數呈現大範圍變動。除此之外，複晶矽薄膜電晶體有較差的次臨界特性(sub-threshold characteristics)，導致其次臨界電流不可忽視。這將會造成實際產品應用上的許多問題，例如類比電路輸出的變動及畫面亮度不均勻的現象。因此，任何複晶矽薄膜電晶體電路在實際操作之前，必須先將元件變動所產生的影響控制在可允許的範圍內。

在本篇論文，我們先描述元件的變動，並進一步研究其對於類比電路的影響以及電路設計技術來補償元件變動的課題。本篇論文的目的之一，為發展一個含有主動負載的新式源極耦合器形式的類比緩衝器電路，來消除輸出不飽和現象及元件變動性，同時增加源極耦合器的驅動能力。此電路的輸出目標電壓能在短時間內穩定，此外輸出誤差與輸

入電壓亦呈現較低的相依性，這代表此電路在不同輸入電壓下均具有很好的補償效果，因此所提出的電路適用於大尺寸及高解析度顯示器的應用。除此之外，我們亦提出一個具有補償元件變動功能的有機發光二極體電壓驅動畫素電路。模擬結果顯示這些提出的電路能成功的補償元件變動的特性，有效改善畫面亮度不均勻的現象，大幅提升影像顯示品質。

Study on the Compensation Circuits of Poly-Si TFTs for Active Matrix Displays

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Abstract

Polycrystalline silicon (poly-Si) thin film transistors (TFTs) have recently attracted much attention in the application on the integrated peripheral circuits of active matrix liquid crystal displays (AMLCDs) and active matrix organic light emitting diode (AMOLED) displays. The significant advantages over amorphous silicon (a-Si) TFTs are in the higher current driving capability and the better reliability. In poly-Si TFT-controlled displays, poly-Si TFTs are used to implement pixel circuits and driving circuits on a single glass substrate to reduce system cost and posses compact module. Therefore, the poly-Si TFT is the best candidate to realize system-on-panel (SoP). However, due to the irregularly distributed grain boundary, poly-Si TFTs have poor uniformity and suffer from huge variation. Besides, the sub-threshold characteristics of poly-Si TFTs are rather poor, so that the sub-threshold current should not be ignored. This will lead to many problems in real product applications such as output variation in analogue circuit and non-uniform brightness in panel. Therefore, before any poly-Si TFT circuit can be put into practice, the influence of the device variation must be suppressed to the acceptable range.

In this thesis, the device variation is described. Its influences on the analogue circuits and circuit design techniques to compensate for the variation are also discussed. One purpose of

this thesis is to develop a new source-follower-type analogue buffer with an active load to eliminate the output unsaturated phenomenon and the output variation from poly-Si device characteristics, and meanwhile, increase the driving capability of a source-follower structure. The output target voltage is settled perfectly with a short charging time, so the proposed circuit is suitable for large-sized and high-resolution displays. Furthermore, the deviation is less dependent on the input voltage, reflecting the good compensation of the proposed circuit. Also, a new voltage driving pixel circuit for the AMOLED is developed to improve the non-uniform brightness of display images. The simulation results indicate that these proposed circuits successfully compensate for the variation of poly-Si TFTs.

Acknowledgements

首先我要感謝我的指導教授戴亞翔博士，老師積極認真的研究態度、大膽前瞻的眼光、講求效率的處事原則及謹慎周全的思慮，是我這兩年中感受最深刻的。感謝老師總是鼓舞我們、激發我們，用心的指導我們，並且提供許多新穎的研究想法，讓我受益良多，有所成長。在此，對我敬愛的戴老師致上最誠摯的謝意。

感謝這一條研究的路上，身邊有無數優秀的研究人才相伴。感謝林彥仲學長在課業上的指導及耐心與我討論相關問題，助我解決研究過程中的諸多疑惑，堪稱是我求學路上的貴人。感謝這兩年來和我一起奮鬥的夥伴們，士哲、宏光、承和、彥甫，謝謝你們豐富了我的生活、也擴展了我的視野。

在此，我要感謝我的家人，總是在背後默默的支持我、給予我高度的肯定並以我為傲，在此我要向他們送上最真摯的感謝。最後感謝口試委員謝漢萍教授、孫文堂博士、葉永輝博士在口試時給予有關電路上的建議與指導。

Contents

Figure Captions

Chapter 2

Chapter 3