以偏軸發光照射實現具有光瞳濾波效果的接觸窗相移圖罩之模擬與研究

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摘 要

隨著積體電路元件尺寸的微縮化,微影製程的線幅寬度(feature size)需求也越來越小，因此一張圖罩(photo mask)內所被要求容納的圖案數量也大大的增加。以目前製程所處的65奈米節點而言，製作邏輯元件的佈局設計裡的接觸窗層的圖罩將會是對微影製程非常嚴苛的一大挑戰。為了達成用一張圖罩同時曝出具有各種間距(pitches)的密集接觸窗以及孤立接觸窗，我們將會需要高數值孔徑的低K1值成像技術，以及各種的解析度增強技術(Resolution Enhancement Technologies)。

解析度增強技術中的偏軸發光照射(Off-Axis Illumination)將有助於密集接觸窗的曝光成像，然而也將使大間距接觸窗的聚焦深度(depth of focus)減少以及圖罩偏差因子(Mask Error Enhancement Factor)變大。著眼此點，我們企圖將超聚焦容忍度加強曝光技術運用在偏軸發光照射上。於是我們先找出一組合適的光瞳濾波法的參數，利用此組參數找出最佳的圖罩調變法的參數，接著用近似圖罩調變法的方式來產生適用於偏軸發光照射的接觸窗圖案。但是這樣子的圖案其製程視窗並不甚理想，必須再經過一些參數上的調整。最後我們將圖案簡化成像是反散條(anti-scattering bar)及緣邊型(Rim-type)相移圖罩綜合體的設計，其製程視窗可和搭配傳統照明方式的緣邊型相移圖罩相比擬。除此之外，用此種設計搭配偏軸發光照射時，在投射光瞳平面上所成的頻譜影像與緣邊型相移圖罩搭配傳統照明時所成的頻譜影像非常相似，都具有超聚焦容忍度加強曝光技術的光瞳濾波效應，能將聚焦深度大幅的提昇。

The Study and Simulation of the Contact-Hole Pattern Phase Shifting Mask with the Benefit of Lens Pupil Filters by Off-Axis Illumination

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Abstract

With the shrinkage of the dimensions of integrated circuit devices, the feature size required in the photolithography is getting smaller and smaller. As a consequence, the amount of pattern that one photomask containing is getting more and more. For the 65-nm process node, manufacturing the contact-hole layer photomasks for the layout of logic device can be the most critical lithographic challenge. To achieve all pitches from dense to isolated simultaneously in a single photomask print ,we requires low-K1 imaging techniques with high numerical aperture (NA) and various Resolution Enhancement Technologies (RET). The off-axis illumination (OAI) is one

kind of RET, it will be helpful to the dense-contact printing. However, OAI will decrease the depth of focus (DOF) of larger pitches contact-hole pattern and increase the mask error enhancement factor (MEEF).

To solve this problem, we attempt to apply “Super-Focus Latitude Enhancement Exposure” (Super-FLEX) to OAI. Thus we find a set of appropriate parameters of pupil filtering method, using these parameters we can find the best parameters for mask modulation method. Then we can generate a contact-hole pattern which is suitable for OAI by the mothod approximated to mask modulation method. But the process window of this pattern is unacceptable. We must tune the parameters of this pattern design additionally. Finally we simplify this pattern and make it seem to the combination of the anti-scattering bar (ASB) and rim-type PSM and its process window is comparable to that of rim-type PSM with conventional illumination. Furthermore, when we using this pattern design with OAI , the spectrum image on the projection pupil plane is very similar to that of rim-type PSM. They are both with the benefit of pupil filtering effect of the Super-FLEX and capable of increasing the DOF.

誌　謝

匆匆的兩年的碩士生涯就要結束了，首先我要感謝我的指導教授羅正忠博士，由於老師給予的細心指導及諄諄教誨，讓我在學術及研究上都有莫大的收穫。並感謝老師在待人處事方面給予的啟發，使我受益良多，在這裡對老師致上內心最誠摯的敬意與謝意。

此外，我要感謝博士班的張仲興學長，謝謝你提供我諸多的專業指導及資源協助，並不厭其煩的幫助我解決模擬實驗的問題，讓我能順利地完成研究。同時，也要感謝曾經一起同甘苦共患難的同學們：伯翰、佳寧、致維、文煜、國源、建華、忠樂、修豪，謝謝你們在精神上給我的鼓勵及安慰，也感謝你們豐富了我的生活。也要感謝昱鈞、建彰、宏仁、俐婷...等學弟妹的協助。另外，我要感謝我的女友月雲，因為妳的支持與鼓勵讓我有勇氣與毅力能夠克服萬難，因為有妳讓我每一天的生活都充滿歡喜。

最後我要感謝我的父母多年來辛苦的栽培與教誨，提供我自由的成長空間，無怨無悔地給我最大的關懷與支持，使我無後顧之憂的完成我的碩士學位。在此獻上內心最深的謝意：爸、媽，謝謝你們～。

Contents

Figure Captions

Chapter 1

Chapter 2

Chapter 3

Chapter 4