

附著力強度與異質接合於三維積體電路應用之 研究


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摘 要



本論文之研究包括金屬與高分子材料的附著力強度測試以及氧化物對高分子材料或不同金屬之異質接合在三維積體電路上的應用，藉由此方案可推進接合技術之混合接合的發展。在材料的選擇及測試，我們主要以銅及高分子材料-苯並環丁烯作 (BCB) 來進行一連串的附著力強度測試；而以矽氧化物對 BCB、鋁對銅和錫對銅來進行異質接合的實驗。在附著力強度測試中，我們比較了不同的金屬膜厚、改變金屬與高分子材料的堆疊順序、以及有無增添鈦或氮化鈮附著層對附著力帶來的影響，並有定量的數據分析以找出最佳的堆疊結構。而在異質接合的部分，我們找出它們適合的接合條件並探討其接合機制，最後在鋁對銅的接合上進行四端克爾文測試結構 (Four-terminal Kelvin test structure) 的電性分析，其中包含多次的循環

交流電應力、長時間的直流電應力和溼度環境下的可靠度測試。



Investigation of Adhesion Strength and Hetero-Bonding for 3D IC Applications

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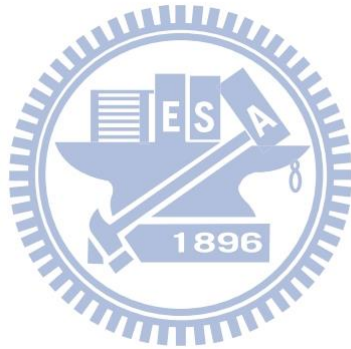
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Abstract:

This thesis focuses on two topics: one is the investigation of adhesion strength between metal and polymer, and the other one is hetero-bonding using oxide-polymer and different metals. These investigation results provide useful information for hybrid bonding development in three-dimensional integrated circuit (3D IC) applications. About material selection for this research, Cu metal and benzocyclobutene (BCB) polymer dielectric were studied as the main materials in adhesion strength test. In addition, silicon oxide-BCB, Al-Cu, and Sn-Cu were fabricated for hetero-bonding investigation. In the adhesion strength test, the effects of layer thickness, layer stacking order, and usage of titanium or tantalum nitride layer between Cu and BCB polymer were investigated. Quantity analysis data was achieved to define

the optimized staking structure. In hetero-bonding study, the bonding condition and corresponding mechanism of each bonding scheme were explored. Finally, Four-terminal Kelvin test structure was fabricated to investigate the electrical characteristics and reliability of Al-Cu bonding, including AC current stressing test, DC current stressing test, and humidity test.



誌謝

回顧碩士研究的生涯，很辛苦卻也相當充實感動。而現在即將要畢業了，我想特別感謝指導老師陳冠能教授，感謝老師帶領我認識半導體的領域，老師的專業知識與建議給我在實驗研究上有了明確的方向更讓我開闊了新的視野，甚至在生活上的相處，老師亦師亦友的風格也讓我們更親近老師讓彼此之間沒有距離。

當然我也要感謝我的家人。雖然我不能時常回家與你們相伴，而你們沒有怨言只有耐心等待與默默祝福，讓我可以無後顧之憂地完成我的學業。也感謝交大電子系所有的教授，你們認真精闢的教導讓我更瞭解半導體、電子、物理及材料的相關知識。另外我也要感謝交大奈米中心(NFC)、清大奈材中心(CMNN)及國家元件實驗室(NDL)的技術人員，他們定時維護機台設備讓我們學生可以安心使用。

最後，感謝柯正達學長帶我找到了碩士班的方向，給予我許多寶貴的建議。和建宇、筌安、世偉一起度過在實驗室的日子，是我這碩士生涯非常寶貴的回憶。也感謝文維學長、亞聖學長、彥斌、毓宸、承浩，星漢和典融學弟，跟我一起做實驗、量測和討論，一起度過了充實的碩班生活。

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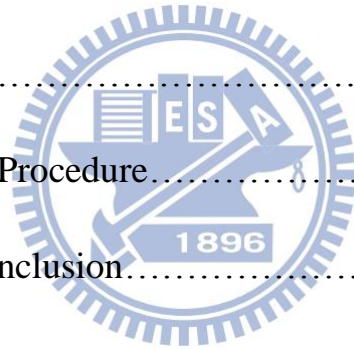
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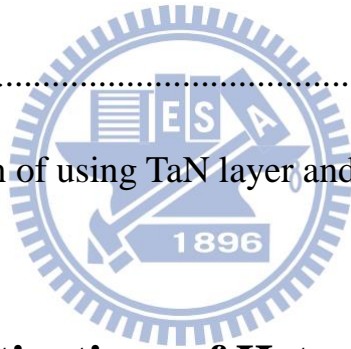
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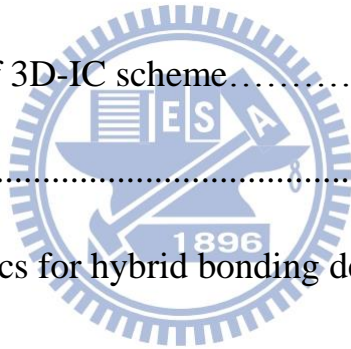
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