附著力強度與異質接合於三維積體電路應用之研究

研 究 生:黃 文 君　　　　　　指 導 教 授: 陳 冠 能 博士

國立交通大學

電子工程學系　電子研究所碩士班

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鉭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

Student: Wen-Chun Huang Advisor: Dr. Kuan-Neng Chen

Department of Electronics Engineering & Institute of Electronics
College of Electrical and Computer Engineering
National Chiao Tung University

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.

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