Adhesion Characterization of Photo-Definable Epoxies on High Aspect Ratio Structures for High Performance Applications

Jan Campbell, Qizhi He, Howie Yang, Martin Ivie

TriQuint Semiconductor Product Sector
Compound Semiconductor Texas
500 W. Renner Rd Richardson, Texas 75080
Phone: 972-415-3218 Fax: 972-994-5768 Email: jan.campbell@tqs.com

Abstract

The adhesion effects of the two different photo-definable epoxies through wet-chemical and plasma treatments have been studied on different thin films. Adhesion is critical in backside processing and the assembly of semiconductors. These high aspect ratio structures (HARS) are exposed to a variety of chemicals and mechanical stresses. Regardless of the wet treatment, without an oxygen plasma treatment prior to coating, the adhesion was negatively impacted. One epoxy (KMPR) demonstrated significant improvements in adhesion over a second epoxy (SU8) on silicon nitride, even before a long cure process. The enhancement of the surface polarity of the KMPR and the enlarged surface contact area due to the increased roughness from the oxygen plasma treatment were the most important factors in the adhesion.

INTRODUCTION

Thick photo-definable epoxies such as SU8 and PMMA have been used for years for creating high-aspect ratio structures for sensors, actuators, and robots used in micro-electromechanical systems (MEMS) as well as for IC packaging, bump plating and etch masks (wet, dry). These epoxies exhibit multiple processing challenges that require extreme process controls with very little process margin, including cleanliness of the incoming substrate, film thickness, uniformity, de-hydration bakes, soft bakes, exposure, post exposure bakes (PEB), develop and final cures, all of which impact adhesion.

Improving and maintaining the adhesion of SU8 to various thin films, such as nitride, oxide, and metals (Au, Al, Cu) have been elusive. Small variations in surface conditions can greatly affect the adhesion of SU8. The importance on adhesion cannot be overemphasized as shear values as high as 40gms on block structures can result in the SU8 delaminating from nitride surfaces (Figure 1: Delamination). .

In this study, various surface treatments were explored to improve the adhesion of SU8 to plasma enhanced chemical vapor deposition (PECVD) silicon nitride. Further KMPR (MicroChem Corp., Newton, Ma, USA) was studied as an alternative to SU8. KMPR showed superior adhesion as compared to SU8 without the long, high temperature cures normally associated with epoxies.

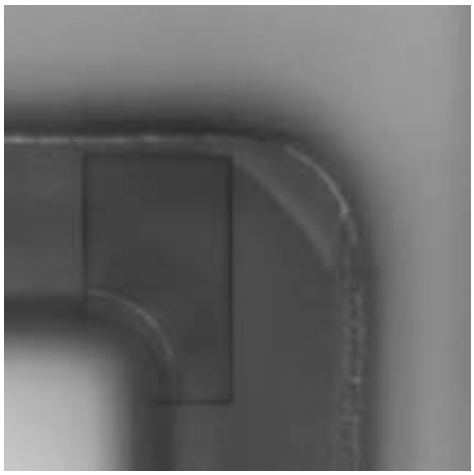

Figure 1: Delamination

EXPERIMENTAL

Test structures were fabricated consisting of SU8 or KMPR blocks and rings 30um sides and 80um height. The adhesion to the underlying layer was tested using a Royce sheer tool. The shear tool increases the force linearly until the structures delaminate or the machine force limit is occurs.

Adhesion Strength

The adhesion strength of SU8 and KMPR are displayed in Figure Two: SU8 and KMPR adhesion. In this test, both SU8 and KMPR were processed the same.