A Novel Process for Singulating Fragile Devices

Ajay Agarwal, S Mohanraj, C. S. Premachandran and Janak Singh
Institute of Microelectronics, 11 Science Park Road, Singapore Science Park II, Singapore 117685
Phone: 65-6770 5927 Fax: 65-6773 1914
Email: agarwal@ime.a-star.edu.sg

Abstract

In recent past, a large number of devices have been developed based on MEMS technology. As a breakthrough technology, allowing synergy between previously unrelated fields such as microelectronics and bio-sciences, many new MEMS applications will emerge that are currently identified or known. The fabrication steps used to form MEMS devices are similar to those for forming integrated circuits but dicing or singulation process and packaging of these devices present some additional complexities. The MEMS devices usually have moving parts that are formed in the final steps of the fabrication, typically known as 'release' of the device. During release a sacrificial layer is removed so that the device can move freely but this makes device very fragile.

Subsequent processes like dicing or any other singulation technique on released devices, pose a real challenge as dicing is typically done using a saw that is mechanically stressful process. Therefore, the MEMS devices are often singulated before release or alternatively, the device should have some enclosures formed over them if they are released before dicing. In case devices are first singulated and subsequently released, the individual handling of each die for release process is expensive and potentially unreliable. To overcome the damages to the fragile or released components of the MEMS devices, various solutions have been proposed.

In this paper, we present a novel process for singulating devices/ MEMS which may be released or unreleased, which have fragile components and/or that have within or without in-plane structures. A typical released device with fragile device components is depicted in figure 1. The process comprises spin-coating of protection material on the back and front of the device wafer after attaching it to holder wafer. The holder wafer is then removed and wafer is mounted on the dicing tape and devices are singulated using dicing saw as shown in figure 2. Individual dies are then picked from the tape and protection material is removed using wet and dry cleaning methods. A singulated die with fragile device components, removed from dicing tape before removing protection layers is shown in figure 3. The process details, its advantages and applications will be presented.

References

1. Kao et al., Method and Apparatus for Singulation of Micro-electro-mechanical Systems, US Patent # 5,923, 995, 1999.
2. Spooner et al., Method and Device for Protecting Micro Electromechanical System Structures during Dicing of a Wafer, US Patent # 6,555,417, 2003.
3. Wang et al., Low Defect Method for Die Singulation and for Structural Support for Handling Thin Film Devices, US Patent # 6,573,156B1, 2003.
4. Aberson et al., Novel Backend Singulation Techniques to Enable Commercialization of Optical MEMS, Proc. of the Intl. Conf. on MEMS, NANO and Smart Systems (ICMENS'03), 20-23 July 2003, pp. 131.
5. Cohn et al., MEMS packaging on a budget (fiscal and thermal), Proc. of 9th Intl. Conf. on Electronics, Circuits and Systems, vol. 1, 15-18 Sept. 2002, pp. 287 – 290.
6. Awatani, et al., Damage free dicing method for MEMS devices, Intl. Conf. on Optical MEMs, Conference Digest 2002 IEEE/ LEOS, 20-23 Aug. 2002, pp. 137 – 138.

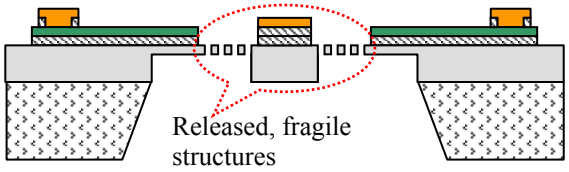

Figure 1: A released device wafer with fragile components.

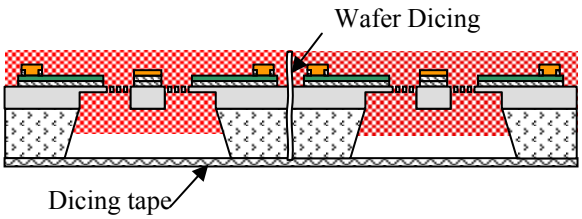

Figure 2: Protected device wafer attached to dicing tape and singulated from the front side of the wafer.

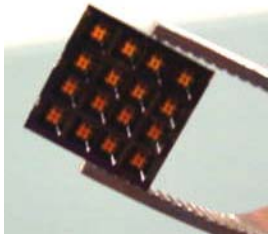

Figure 3: Singulated die with fragile device components, removed from dicing tape before protection layers removal.