

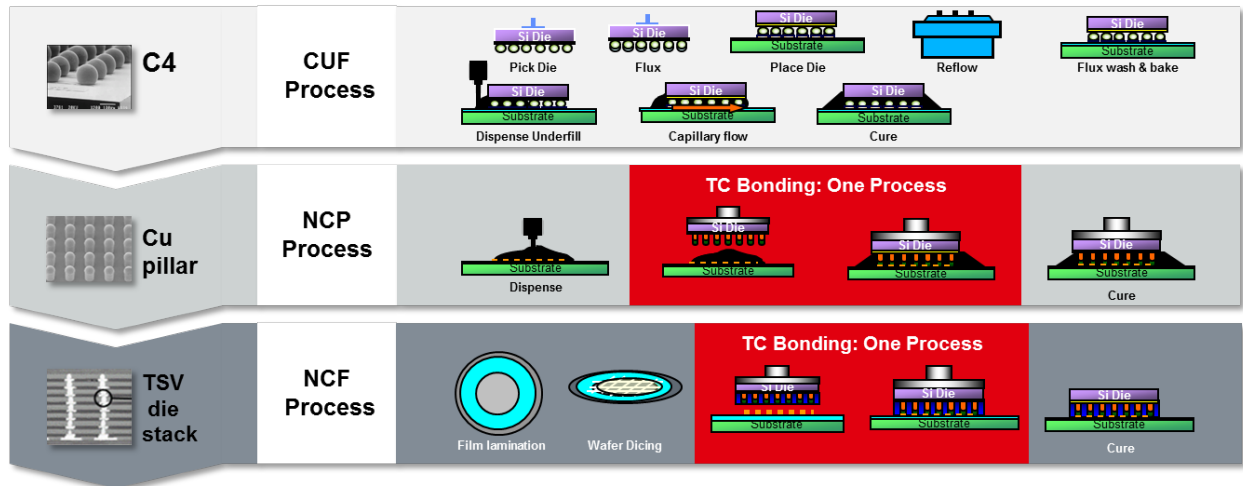
Advanced Packaging Technologies get Reliability Boost from NCF Material

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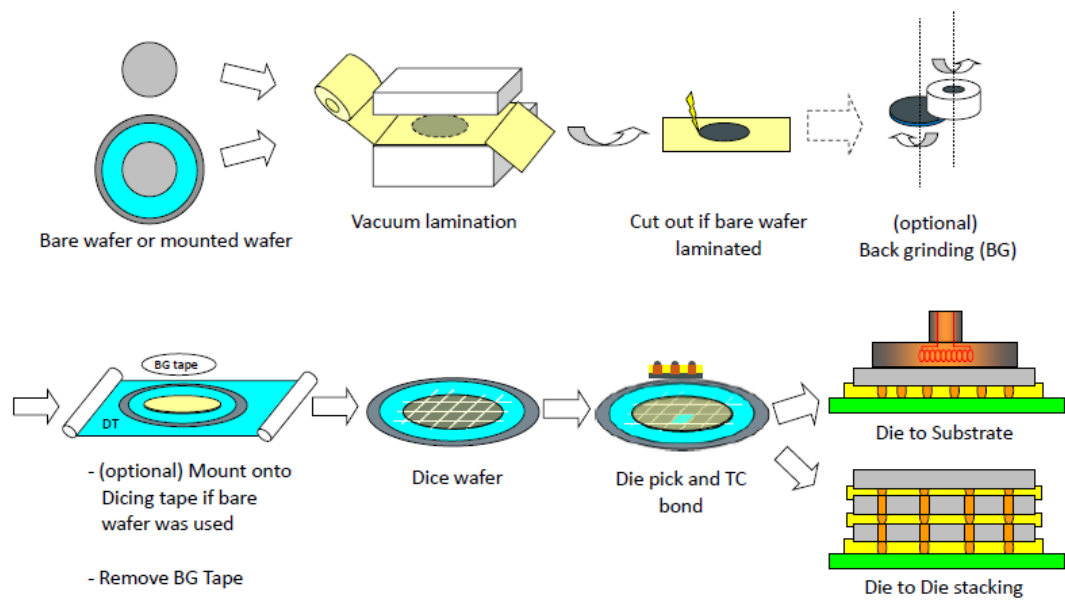
The past decade has witnessed dramatic growth in mobile and computing technology, a market dynamic that has driven the development and adoption of various interconnect solutions. Traditionally, transistor scaling has been the technique used to advance form and function, but this method has become increasingly challenging and costly. Therefore, many device designers are considering new advanced packaging techniques to address the continued requirement for high performance and increased functionality. Modern package designs include increased I/O, system-in-package and higher interconnect densities, among others.

As newer packages become thinner and smaller with more I/O for greater function, ensuring the reliability of the designs becomes essential to long-term performance. Stress management and structural bump protection are critical factors, as chips are more fragile than ever with lower silicon nodes and ultra-low dielectric layers. Wafers and dies with through silicon vias (TSVs) are thinner to accommodate 3D stacking and thinner substrates are already available, making handling and warpage control more challenging. Achieving higher functionality for a given die size has also given rise to copper (Cu) pillar technology. This technique allows designers to place Cu pillar bumps in higher density, enabling increased I/O and utilizing wafer functionality. But, like other challenging designs, Cu pillar bump pitches of less than 50 μm and narrow sub-40 μm bondline gaps make conventional bump protection methods increasingly problematic. Traditional capillary underfills (CUFs), for example, are hard-pressed to flow in and around the tight dimensions. Because flux cleaning under the tight spaces is also challenging, underfill compatibility with flux residues is a growing concern. In addition, new substrate solder mask designs such as partial or full solder mask openings (SMOs) are making the underfill process more complex and void-prone due to the added substrate topography.

Because of these realities, non-conductive paste (NCP) and non-conductive film (NCF) – also referred to as wafer-applied underfill (WAUF) – materials have emerged as the most reliable underfill solutions for Cu pillar and TSV packaging approaches. Both NCP and NCF materials offer excellent bump-pad alignment accuracy through thermal compression bonding, as shown in the process diagram below.



In the memory market, however, where 3D TSV stacking applications have evolved into the dominant packaging technique, TSV die applications less than 100 μm thick are challenging for thermal compression bonding of paste materials. Because of the potential for die top and bonding tool contamination with NCPs, packaging specialists have moved toward the use of NCF for die structures – including TSV and Cu pillar -- where more controlled flow and fillet formation are required. As illustrated in the below diagram, the NCF is applied via lamination and not only protects the bumps on the wafer, but also serves as additional support for wafer handling and successive processing. Bump protection is achieved immediately following thermal compression bonding, and die stacking of TSV dies is highly viable.



The latest NCF material to be introduced to market is a 2-in-1 wafer-applied underfill film from Henkel. Henkel's NCF has been developed to facilitate die processing for die that are less than 60 μm thick and, as compared to previous generation materials, the new NCF has a long work life of 8 weeks; 6 weeks with the backgrinding tape and an additional 2 weeks once the

backgrinding tape is removed. Not only does the backgrinding tape facilitate wafer thinning when required, it also delivers handling stability and enables complete NCF gap filling and coverage for maximum bump protection. The material has lower melt viscosity which allows for lower bond force processing, exceptionally fast three-second cure, a four-month shelf life and no outgassing during processing. Henkel's NCF has been designed to balance flow behavior and cure kinetics to achieve good joints without entrapment or solder extrusion, provide good fillet coverage and complete gap filling.

In addition to all of the performance and reliability benefits afforded by NCF, film-based materials are ideal for the requirements of memory chip processing and, even for non-memory applications, enable the close placement of die, which is not achievable with paste-based materials. As the industry moves toward more challenging designs and 3D integration, advanced materials such as Henkel's new non-conductive film will be essential for robust wafer processing and long-term package reliability.

For more information about the benefits of NCF for advanced packaging processing, send an e-mail to rose.guino@henkel.com. Henkel's full portfolio of semiconductor materials can be found by visiting www.henkel.com/electronics.