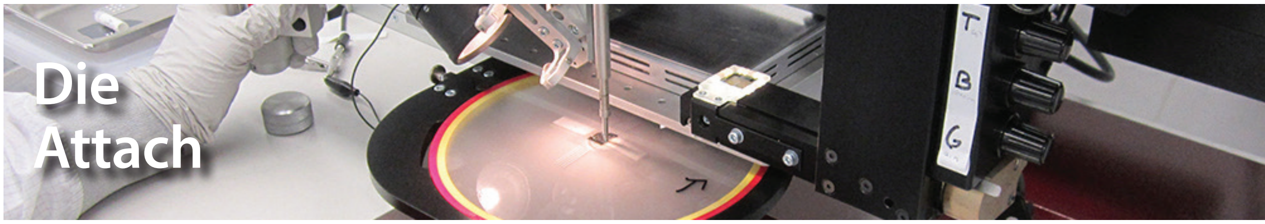

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Factors to Consider for an Effective Die Attach Strategy

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DIE ATTACH METHOD IS IN EVERY way fundamental to microelectronic product design. Unfortunately, during the early product development and design phase of a new microelectronic product, very rarely is the die attach strategy given enough consideration. Although there are many die attach methods available (thermal compression bump bonding, brazing, and soldering) the focus of this article will be one of the most popular methods: adhesive die attach. In the realm of adhesive die attach there are many basic properties that can drastically affect the product function or production process. These properties include adhesion, rigidity, viscosity at dispense, working life, cure method, and cure temperature. Each of these parameters (as well as some not mentioned here) need to be carefully considered.

Adhesion

Fundamentally all die attach methods must serve as a structural attach to the package. Many of the die found in today's sensors also depend on the attach method to provide a proper fluid seal around the fluid path. If the die attach method is also a fluid seal, then it must also have adequate adhesion to form a proper seal around the wetted perimeter of the die. Die that require fluid seals are typically pressure sensors. In addition to serving as a fluid seal the attach material is also a pressure seal. In these cases, selecting an adhesive that has adequate adhesion to both the die and the package is vital. To test seal attach adhesion a shear tester can be used. This test will destructively shear the die off of the package, measure the force, and evaluate the failure mode. It is important that the shear force meets or exceeds the theoretical calculated shear value for the geometry of the part. It is also important to confirm that the failure occurs in the adhesive layer and not in the boundary interface between the adhesive and the package or the adhesive and the die. This is a way to validate the adhesion strength and avoid a structural weakness or potential leak paths.

Rigidity

The rigidity of the elastomeric material formed by the cured adhesive can be an important factor in the product design. This is a factor that too often gets overlooked on the first or second design iteration. If the joint is too rigid then there is a real possibility that strain on the outside package will affect the die output. This is known as a parasitic strain induced offset. In some cases, if the bond is not stiff enough, the opposite can occur. The die will experience movement in the package during pressurization, vibration, or mechanical shock. This will affect the life of the sensor and contribute to possible offset shift. It is important to select the proper adhesive for the application and the life of the sensor.

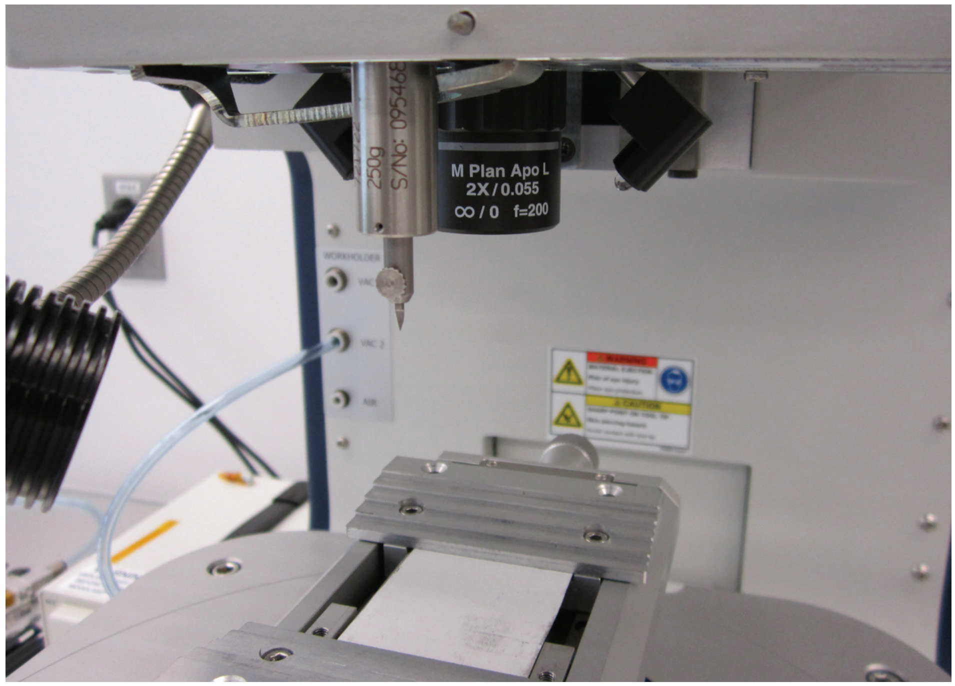


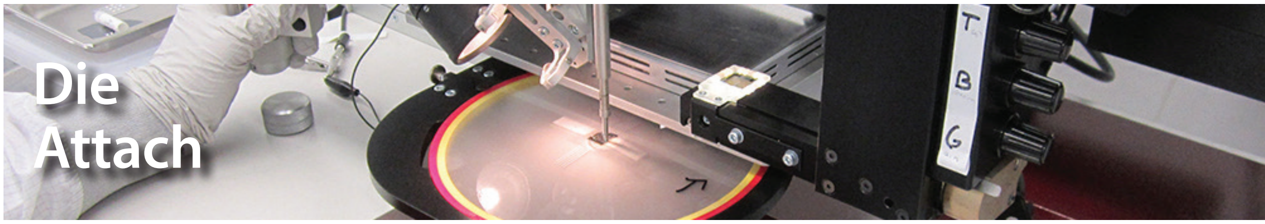
Figure 1. Shear test equipment for evaluating die attach method.

Dispense and Working Life

Most of the elastomeric adhesives used in the die attach process are dispensed in place at time of assembly. The viscosity and working life of an adhesive are critical material properties that can have a significant impact on the assembly process. The amount of material required to securely fasten the die (and form a seal) is governed by the geometry of the part and the viscosity of the adhesive. If the selected material is viscous, or thixotropic, it will likely form in place. If the selected material has a low viscosity then material dams may need to be designed into the structure to keep the material in place to form a seal. The working life of the material also needs to be considered. If the adhesive thickens during the dispense process then the dispense process will constantly change. This adds complexity to the assembly process. For example, if the adhesive is getting more thixotropic during dispense then the amount of adhesive dispensed per part may be reduced due to the reduced flow in the dispense head. Each successive part will have less and less adhesive on it. This will lead to a very unstable and changing process.

Cure Method and Temperature

Cure type (sometimes called cure profile) of the adhesive is an important process consider-



ation. Recently, there has been an emphasis on room temp cure adhesives for sensors (such as chemical sensors). The special surface preparation of many of these die cannot tolerate elevated cure temperatures. Because of this, designers are favoring two-part epoxies and room temperature humidity cure adhesives. Two-part epoxies tend to have a reduced working life and stiff post-cure properties. Humidity cure adhesives cure from the outside surface in and actual cure condition can vary. This can be a disadvantage if the device requires a calibration. If the adhesive is not fully cured before calibration then the device will likely develop a variable offset shift after the assembly process. The best overall adhesive sealants are heat cure adhesives. Heat cure adhesives have a predictable and well defined cure cycle. This allows the process to be designed to insure that the entire adhesive bead is cured properly in every part. It is worth keeping in mind that the entire assembly will need to be exposed to the cure temperature of the adhesive.

Other Challenges

Today there are volumes of books that contain tens of thousands of elastomeric adhesives to choose from with more on the way every day. Designers and process owners are fortunate to have so many choices. However, the unintended consequences of choosing the wrong adhesive are too numerous to mention them all. Additionally, there are a few more common process issues that need to be addressed. The first, foremost, and most well-documented process issue associated with adhesive dispense is the presence of bubbles in the finished part. These bubbles will swell and contract during pressure changes and create stress in the package. If the material is hygroscopic the bubbles may fill with water and cause additional problems. It is imperative that the adhesive material be bubble free at, during, and after the dispense process. Bubbles in adhesive can be caused by a variety of things including moisture in the packaging materials. If the package is a plastic or FR-4 PCB type material, it will attract moisture from the environment. When heated or placed in vacuum the moisture will boil off in the form of H_2 and O_2 gas creating gas bubbles that become trapped in the adhesive.

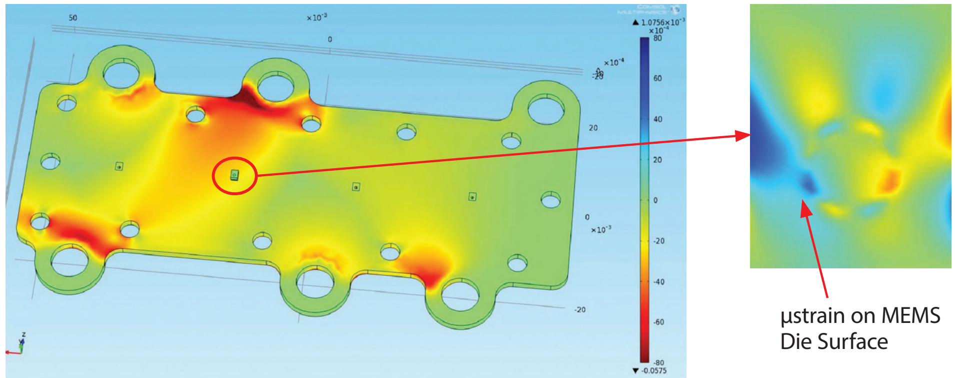


Figure 2. Finite element analysis of strain induced by the package. *Courtesy of www.dceams.com*

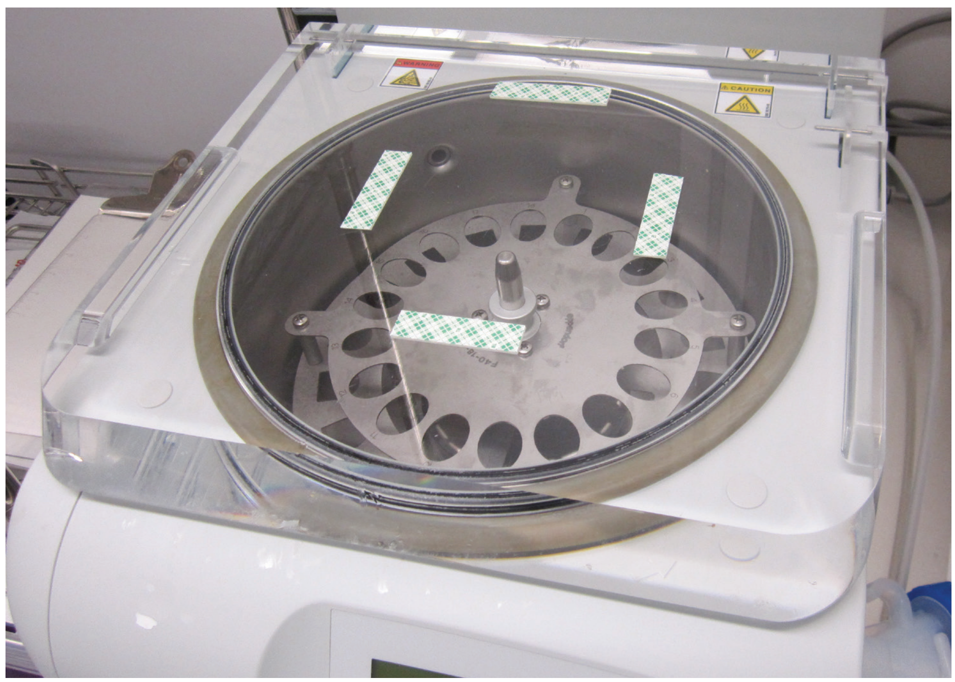


Figure 3. Vacuum centrifuge used to remove bubbles before dispense.

Implementing a strategy for developing a die attach method for a new microelectronic product is critical in the early product development and design phase. Adhesive die attach contains numerous properties that can affect both the product function and the manufacturing process. There are so many choices out there in elastomeric adhesive sealants. Each adhesive has its own set of advantages and drawbacks. There are plenty of intended and unintended consequences to all of them. It is important to consider the choices carefully and thoughtfully as early as possible in the design process. This is the best way to avoid common pitfalls and ensure the development of a successful die attach method.