Polymeric Film Technology for the Jettable Fluid Delivery Assembly and Harsh Environment Protection

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Abstract

Jettable fluid delivery and other microelectro mechanical (MEM) devices are becoming smaller in addition to being exposed to more extreme environments. These devices or packages rely on polymeric materials as structural adhesives for the assembly of various substrates. These polymer materials also provide protection from mechanical shock, extreme thermal cycles, and can withstand long exposure to the harsh chemical environment of the jetting fluids. Because these devices are becoming smaller, it is more difficult to accurately apply the structural adhesives. This poster will discuss an alternative adhesive format which is a very precise thickness film. These films are versatile and are designed with many physical and property options such as: supported or unsupported, thermally and/or electrically conductive, dielectric, low temperature attach and low voiding. In addition, the paper will describe the various film formats, film attach techniques and the part assembly processes.

Introduction

The manufacture of jettable fluid delivery devices requires the precise assembly of various components. The structural integrity and reliability of the assembled components can be achieved through the use of molding materials, mechanical fasteners, and structural adhesives. Structural polymeric adhesives are most often the ideal choice because they mate the substrates to form a continuous surface. The bonding surfaces often consist of multi-layer silicon die, thin and thick wall engineered plastics, noble metals, and flexible substrates. Adhesives then become the barrier holding fluids within the device and also prevent the outside environmental contaminants from entering the device. Smaller devices make it more difficult to accurately apply the structural adhesives. The alternative adhesive film format provides uniform thickness and can be precisely cut to fit the bond area.

Film Format

Film format adhesives consist of multiple layers. The outer layer is a release liner or tape that is removed prior to assembling the bond. The release liner protects the film adhesive from contaminants during storage and handling. The next layer is the film adhesives. The adhesives are cast dried resins and can be easily cut into the shape of the bond area for precision placement.

The film adhesive can be unsupported or supported. An unsupported adhesive film is just adhesive sandwiched between two release liners. A supported film adhesive consists of an additional layer of support tape with the adhesive coated on one or both sides of the tape. This support tape is called the carrier. The carrier functions to provide more mechanical strength to the adhesive. The carrier may be solid to provide additional barrier properties or a mesh to allow the adhesive to imbed the carrier. Very thin adhesive layers are possible for both the unsupported and the supported formats. The film thickness is the sum of the dry adhesive and the carrier.

Application

Film adhesives are cut to fit the bond dimensions. The film adhesive and the bonding substrates are then attached together. Heat is used to soften the film adhesive and pressure is applied to attach the film to the substrates being assembled. Uniform pressure is required to prevent voids and air pockets from forming in the bond area. In addition, pressure will help the thin film adhesive conform to the topography of the substrates. Once assembled, some films require a heat step to complete the cure process. Pressure or mechanical fixturing will ensure that the film adhesive maintains its position during the cure.

Chemistry

The film adhesives can be thermoset or thermoplastic. Both thermoset and thermoplastic film adhesives go through similar attachment processes. Thermosets, however, require an additional cure step to create a permanent bond. The base chemistry for these thermoset film adhesives is often heat cure epoxy with various curatives to provide a wide cure temperature range starting at 100C.

The “cure”-and-attach temperature and the time for the thermoplastic adhesives are one and the same. The thermoplastic attach temperature is higher to ensure that the thermoplastic film adhesive will not reflow in the operating temperature range of the device.

Both types of the film formats, unsupported and supported, can be filled. Films can be electrically conductive, thermally conductive or insulating.

Compatibility with Fluids

Film adhesives demonstrate good stability and adhesion at operating temperatures in harsh fluids, which make them suitable for use as adhesives, sealants and encapsulants for circuit assembly protection.

In this poster, various substrates are examined by adhesion testing before and after chemical environment exposure in commercial dye and pigment aqueous inks. Adhesion tests often must be developed for a specific part design. Some standard tests such as die shear can be used for screening various adhesives. Adhesive strength often decreases after chemical exposure.

Conclusion

Most often a combination of tests is required to match the adhesive with the application. The bulk properties of the adhesive may not withstand the environment or the harsh fluids may attack at the substrate interface. In addition, the failure mode may be related to the mechanical or thermal stresses, assembly techniques, incomplete cure, or improper surface preparation. The ideal test is

to assemble a “real” part and observe performance over the anticipated useful life, while exposing the part to expected environmental hazards.