Form-in-Place Adhesive Gasket to Waterproof an Electronic Device

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Form-in-Place Adhesive Gasket to Waterproof an Electronic Device

Abstract:

This publication describes a form-in-place adhesive gasket used to create a waterproof seal between mating surfaces of an electronic device. The form-in-place adhesive gasket includes an elongated foam seal that is compressible and filled with a curable liquid adhesive. During assembly of the electronic device, compressive forces between the mating surfaces of the electronic device squeeze the elongated foam seal to discharge the curable liquid adhesive from open ends of the elongated foam seal. The discharged curable liquid adhesive fills gaps in regions between the open ends of the elongated foam seal and other barriers that may seal portions of the electronic device.

Keywords:

compliant foam, compressible foam, liquid adhesive, adhesive foam, compressible seal, compliant seal, discharged adhesive, filled foam void, waterproof, water-resistant, sealant

Background:

An electronic device, such as a smartphone, must often be waterproof. In such an instance, the physical dimensions and manufacturing tolerances of the electronic device may inhibit multiple aspects of a waterproof design that prevents water from penetrating between mating surfaces of the electronic device. For example, a waterproof design that relies significantly on a dispensed adhesive (e.g., a silicone epoxy dispensed between the mating surfaces) may require multiple dispensing setups that add to manufacturing cycle time. As another example, a waterproof design that incorporates segments of materials (e.g., a foam material, a rubber material, a dispensed
adhesive material, a pressure-sensitive adhesive material) may have discontinuities at intersection points between the segments of the materials, creating paths for water (or other invasive elements) to penetrate into the electronic device.

It is therefore desirable for the electronic device to incorporate a form-in-place adhesive gasket that minimizes the waterproof design’s reliance on a dispensed adhesive and that mitigates water penetration paths that may be present between segments of materials.

Description:

This publication describes a form-in-place adhesive gasket used to create a waterproof seal between mating surfaces of an electronic device. The form-in-place adhesive gasket includes an elongated foam seal that is compressible and filled with a curable liquid adhesive. During assembly of the electronic device, compressive forces between the mating surfaces of the electronic device squeeze the elongated foam seal to discharge the curable liquid adhesive from open ends of the elongated foam seal. The discharged curable liquid adhesive fills gaps in regions between the ends of the elongated foam seal and other barriers that may seal portions of the electronic device.

Fig. 1, below, illustrates an example elongated foam seal that is part of the form-in-place adhesive gasket. The top of Fig. 1 shows the elongated foam seal in an uncompressed state. The elongated foam seal has an internal void that is filled with a curable liquid adhesive during manufacturing (e.g., the elongated foam seal may include a “closed-cell,” non-porous foam material having an internal void that is “hollowed out” during manufacturing and effective to prevent a curable liquid adhesive that is injected into the elongated foam seal from leaking radially through the elongated foam seal). The elongated foam seal also includes adhesive on opposing
surfaces (*e.g.*, a dual-sided adhesive) that may (i) fix a position of the elongated foam seal as it is compressed between two mating surfaces of an electronic device and (ii) provide tensile forces to join the two mating surfaces.

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**Fig. 1. Elongated Foam Seal**

The bottom of Fig. 1 illustrates the elongated foam seal in a compressed state. As shown, a compressive force (*e.g.*, a force generated by bringing the mating surfaces of the electronic device together) squeezes the elongated foam seal to discharge the curable liquid adhesive from the open ends of the elongated foam seal.

Fig. 2, below, illustrates additional details of the example elongated foam seal. The top of Fig. 2 shows temporary end caps that might be attached to the elongated foam seal during manufacturing to contain the curable liquid adhesive until the elongated foam seal is compressed (*e.g.*, the end caps are removed immediately before compressing the elongated foam seal). The top of Fig. 2 also illustrates an example section-line (*e.g.*, Section A).
The bottom of Fig. 2 illustrates a section view of the elongated foam seal at a location corresponding to Section A. As shown, the elongated foam seal has an uncompressed thickness dimension (\(T_u\)), a compressed thickness dimension (\(T_c\)), and a width dimension (W). A nominal value of \(T_u\) may range, for example, from 0.20 millimeters (mm) to 0.50 mm, while a nominal value of \(T_c\) may range down to 40% of \(T_u\) (e.g., 0.08 mm to 0.20 mm). A nominal value of W may range from a factor of 100% of \(T_u\) to 400% of \(T_u\) (e.g., 0.20 mm to 2.00 mm). The curable liquid adhesive may be curable using a variety of environmental conditions, including curing the curable liquid adhesive at room temperature or curing the curable liquid adhesive at an elevated temperature.

![Fig. 2. Elongated Foam Seal Details](image)

Fig. 3, below, illustrates an example use-case of the example form-in-place adhesive gasket. The top of Fig. 3 shows aspects of an example electronic device. The electronic device
may be, for example, a smartphone, a tablet, a wearable device, a television, and so on. The electronic device includes a cover glass (e.g., a cover glass covering a display of the electronic device) and a housing (e.g., a plastic or metal housing that encloses electronic components of the electronic device, such as the display, a printed circuit board, integrated circuit devices, a power supply, wireless-communication hardware, and so on). Surfaces of the housing and/or cover glass to be joined and sealed may have contours and/or shapes.

The housing, as illustrated, includes an upward-facing surface that mates with a downward-facing surface of the cover glass. The upward-facing surface of the housing includes a first region to which manufacturing processes dispense an adhesive and a second region to which manufacturing processes attach the elongated foam seal.

![Form-in-Place Adhesive Gasket Use-Case](image)

**Fig. 3. Form-in-Place Adhesive Gasket Use-Case**
The bottom of Fig. 3 illustrates the aspects of the example electronic device after assembly. During assembly, compressive forces between the cover glass and the housing squeeze the elongated foam seal to discharge the curable liquid adhesive from the open ends of the elongated foam seal. As illustrated, and after being discharged, the curable liquid adhesive fills a region including a gap (e.g., a discontinuity) between an end of the elongated foam seal and the dispensed adhesive. The filled gap/discontinuity seals the region and prevents water penetrating into the electronic device, protecting electronic components from damage. The combination of the compressed, elongated foam seal plus the discharged curable adhesive can be, in effect, a form-in-place adhesive gasket.

The form-in-place adhesive gasket, which may also be referred to as an “adhesive éclair,” has many alternative implementations. As a first example, the mating surfaces of the electronic device may include recesses and/or channels to align the elongated foam seal and control dispersion of the curable liquid adhesive. As a second example, the elongated foam seal may include an “open-cell,” porous foam material that allows the curable liquid adhesive to discharge in a radial direction through the elongated foam seal, thereby eliminating the need for a dual-side adhesive. As a third example, the elongated foam seal may include multiple internal voids, where each internal void is filled with a different element of the curable liquid adhesive (e.g., a first internal void may be filled with an epoxy resin of the curable liquid adhesive and a second internal void may include an epoxy curing agent of the curable liquid adhesive). And, as a fourth example, the curable liquid adhesive may rely on a light-based curing mechanism (e.g., light passing through the cover glass may cure the curable liquid adhesive).