

## Measurements and Observations on Adhesion to Brittle Materials

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Bonded systems between different material families (metals, ceramics, and polymers), and within each family are widely used. A few examples include: polymer coated dielectrics, encapsulated electronic packages, brazed and soldered assemblies, glass to metal seals, plated and coated electrical contacts, coatings on tribological materials, and arc-sprayed components. The performance of such multi-materials systems is often limited by the adhesion between the layers. Experimental observations and measurements of interfacial properties in ceramic-polymer/metal systems are described. Spherical shaped indenters have been used to induce delaminations at the interface. The load for initial delamination is used to measure the interfacial strength, while the load-crack length relationships are used to estimate interfacial toughness. In the ceramic-polymer system used for dielectric protection, surface chemical modifications led to enhanced interfacial toughness, and various modelling approaches needed to properly characterize the system are highlighted. In the ceramic-metal cases described, the interfacial microstructure changes during processing or use (high temperature sealing, and solid-oxide fuel cell applications). Here we will highlight the reasons why multi-scale models are necessary for accurate descriptions of performance, and how experimental techniques can help in building these models.

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