ABSTRACT: Biomechanics is now a major area of materials research. The mechanics of fracture and other damage modes in engineering ceramic coatings on soft substrates are of special interest because of the potential for premature failures in biomechanical prostheses—dental crowns, hip replacements, etc. In this presentation we characterize contact damage modes in model layer systems that simulate the basic features of biomechanical structures (especially dental crowns), and at the same time allow direct experimental observation of the system responses during loading. Experimental data on model bilayers and trilayers are used to validate the relations. Use of the results to provide a sound basis for the design of layer systems with optimal damage thresholds will be discussed.