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Simulations of fracture in coatings with complex microstructures

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SIMULATIONS OF FRACTURE IN COATINGS WITH COMPLEX MICROSTRUCTURES

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This talk will describe simulations of fracture based on discrete element formulations, which are designed to predict failure without assumptions regarding damage modality (e.g. delamination versus channel cracking). The goal is to quantify connections between active failure modes and microstructural properties and features, such as columnar architectures, oxide rumples or regions with CMAS infiltration. The computational tool incorporates cohesive elements at every single interface formed between continuum elements, thus allowing for arbitrary crack paths to emerge as a consequence of local stresses. The method reduces to conventional linear elastic fracture mechanics in the limit of large crack length relative to the cohesive zone size, with an intrinsic toughness Explicit time stepping is used to avoid convergence issues associated with implicit methods, provide a natural pathway to incorporate rate-dependence, and enable high degrees of parallelization. The talk will provide a number of illustrative simulations, and outline their implications regarding the scaling of computational expense with various material features, with an emphasis on the potential gains afforded by GPU parallelization.