ATOMISTIC MODELING OF SUSTAINED FATIGUE CRACK GROWTH UNDER REALISTIC CONDITIONS

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This presentation will review the Cornell Fracture Group's effort to apply modern atomistic based simulation techniques to advance the mechanistic understanding and models of fatigue crack initiation in naval aviation. The overall effort is aimed at (1) bridging the gap between existing fatigue initiation models and real-world service conditions, (2) providing mechanistic based material separation rules for microstructural models, and (3) identifying nanoscale routes for improved fatigue performance/mitigation via new alloys, coatings, and/or treatments. Broadly, improved fatigue prediction capabilities may translate to fewer unexpected failures, decreased ownership costs, and the increased availability of existing aircraft.

Observations of fatigue cracks emanating from material defects such as corrosion pits are very common; yet, one can argue that fatigue crack nucleation and subsequent growth has never been predicted in a fundamental model (i.e. ab-initio or even atomistic). Over the past decade, the Cornell Fracture Group has worked in this area, focusing primarily on the crack-tip chemomechanics associated with environmental effects. More recently, the group has been directing its attention towards the more fundamental question of what conditions make sustained fatigue crack growth possible. This presentation will discuss the hypotheses that we have made, the subsequent test simulations/model that have been performed, and the conclusions that can be drawn.