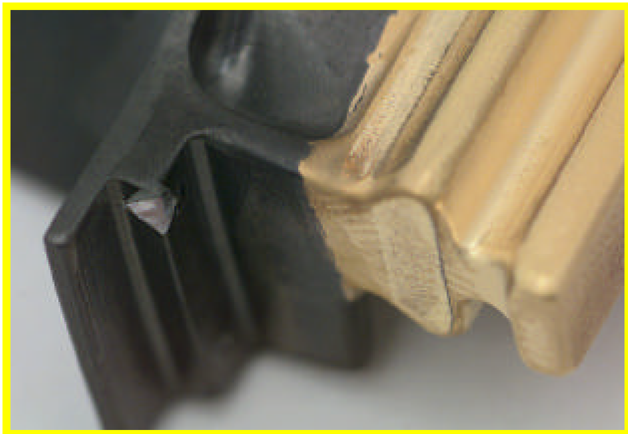
Failure Criteria for Anistropic Materials



Objective

This effort will develop/refine analytical tools for anisotropic materials such as single crystals, ceramic composites, and laminate composites. These materials have unique properties making them attractive for use in harsh environments when the failure modes are not well characterized. The analysis tools in use today do not readily address basic strength, fatigue life, and fracture mechanics for anisotropic materials over the possible range of material orientations used in the design. The unique nature of the failure modes of these materials makes them distinctly different from the analytical approaches used for isotropic materials. The tools and methodology developed to address basic strength, fatigue, and fracture mechanics in these high technology materials will address the current needs for materials presently in use. The analysis of materials developed and selected for use in future designs will require only that the material be laboratory tested so its unique properties and failure mechanisms can be accounted for in the tools developed.

Why Needed

Analysis of anisotropic materials currently does not readily account for the unique failure modes of selected materials. Also, the current techniques assess only a few material orientations, but the materials' capability to withstand the loading environment can dramatically change with material orientation that is within the design limitations. The developed tools will allow use of material unique failure criteria for strength, fatigue, and fracture growth, and automate the multiple analysis passes required to properly assess the total material orientation within the design. An analysis of the effect and orientation of a single crystal material within the allowed range in the High Pressure Fuel Turbopump/Alternate Turbopump (HPFTP/AT) first stage blade showed large variation in fatigue capability. This was verified by blade cracking during engine testing. The analysis to show this was complex, lengthy, and cumbersome. This proposed effort will further develop the failure criteria proposed in the HPFTP/AT blade analysis and develop convenient tools for timely analysis. The anticipated results of this effort will provide tools and methodology to properly analyze and predict failure in complex materials used in complex environments. The results will be in two areas: the assessment and development of failure criteria, and the analytical tools to apply these criteria to complex structures.

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Sponsor

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