LIFE PREDICTION AND CONSTITUTIVE MODELS FOR ANISOTROPIC MATERIALS

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The trend toward improved engine efficiency and durability is placing increased demands on gas turbine materials, especially in the hot section. New materials and coatings are being developed to meet these demands. A particular area of challenge is in the turbine airfoil components. Here single (SC) and directionally solidified or recrystallized (DSR) polycrystalline materials are finding application. A difficulty impeding the full implementation of SC or DSR materials is the limited knowledge and understanding of failure (crack initiation) mechanisms and constitutive behavior.

The intent of this program is to develop a basic understanding of cyclic creep-fatigue deformation mechanisms and damage accumulation, a capability for reliable life prediction, and the ability to model the constitutive behavior of anisotropic SC and DSR materials employed in turbine airfoils. Four options comprise the program, and the work breakdown for each option reflects a distinct concern for two classes of anisotropic materials, SC and DSR materials, at temperatures encountered in the primary gas path (airfoil temperatures), and at temperatures typical of the blade root attachment and shank area. Work directed toward the higher temperature area of concern in the primary gas path includes effects of coatings on the behavior and properties of the materials of interest. The blade root attachment work areas will address the effects of stress concentrations associated with attachment features.

CONTRACT: CYCLIC CONSTITUTIVE MODELING AND LIFE PREDICTION METHODS FOR ANISOTROPIC MATERIALS.

OBJECTIVE: DEVELOP AND VERIFY CYCLIC MATERIALS CONSTITUTIVE MODELS AND LIFE PREDICTION METHODS FOR COMPONENT SPECIFIC ANISOTROPIC MATERIALS FOR USE IN STRUCTURAL ANALYSIS COMPUTER PROGRAMS.

DURATION: 5 YEAR, 35 MAN-YEAR EFFORT.

PROGRAM STRUCTURE: FOUR PHASE PROGRAMS, EACH PHASE AN OPTION

- o PHASE 1 - COATED SC AIRFOILS
- o PHASE 2 - COATED DS AIRFOILS
- o PHASE 3 - UNCOATED SC BLADE ROOT
- o PHASE 4 - UNCOATED DS BLADE ROOT

APPROACH:

- o SELECT MATERIALS AND COATINGS
- o SCREEN ADVANCED CONSTITUTIVE AND LIFE PREDICTION MODELS; SELECT BEST
- o INTEGRATE MODELS WITH STRUCTURAL ANALYSIS PROGRAMS
- o VERIFY IN SIMULATED COMPONENT TEST

PROGRAM WILL ADDRESS:

- o CREEP-FATIGUE
- o THERMOMECHANICAL FATIGUE
- o ORIENTATION EFFECTS
- o COATING/SUBSTRATE INTERACTIONS
- o BIAXIAL LOADING
- o ATTACHMENT STRESS CONCENTRATIONS