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SPECIFIC FAILURE MODES OF NI-BASE SUPERALLOYS AND TBCS UNDER A SIMULATED COMBUSTION GAS ATMOSPHERE

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A new test bed has been developed which enables us to apply complicated thermo-mechanical fatigue (TMF) loadings to superalloy specimens in order to simulate the conditions and significant temperature gradients that are experienced in components that operate in a combustion gas flow environment. Employing this system, the thermally graded creep (TGC) tests were carried out for the superalloy substrate specimens and the coated specimens with thermal barrier coatings (TBCs). Some combined TGC (CTGC) tests in which the TGC loading was applied to the specimen under the thermal cycles were also done. Through the work, special attention was paid to the specific damage morphologies and the deformation under the TGC and CTGC condition. It was shown that some types of specific damages were experimentally discovered under the above specific TGC and CTGC tests. A significant difference was found in the cracking behavior of the ceramic top coat in the TBC specimens, among the TGC, CTGC and the pure creep tests. As an extension of these works, the subject on the effect of CMAS combustion products on the dagame evolution of TBCs was also studied, by means of the new bed. It was found that the CMAS introduced not only the material degradation but also the mechanical attack to the ceramic top coat, resulting in a reduction in life time for spallation and delamination. Discussions are also made on the mechanics and mechanisms on these damage evolution.

Keywords: Temperature gradient, Thermally graded creep, Thermal cycles, Thermal barrier coatings (TBCs), CMAS, Spallation and delamination.

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