Ceramic Matrix Composites

Prediction of Ceramic Matrix Composites Lifetime in High Temperature Static Fatigue based on a Probabilistic Fracture Mechanics Model
O De Melo-Loseille, J Lamon (Univ de Bordeaux/CNRS)
The time-to-failure of ceramic matrix composites is controlled by fibre fractures, during static fatigue, in air, at temperatures ranging from 400°C to 1200°C. A probabilistic fracture mechanics model is proposed to predict variations in fiber tow flaw density functions. Strength-Probability-Time diagrams for composites are established. (D4:1)

AE Monitoring of Microdamages in 3D-Woven SiC/SiC Composites under Thermal Stress Induced by Direct Diode Laser Irradiation
T Hayashi, S Wakayama (Tokyo Metropolitan Univ)
The thermal shock test method using direct diode laser (DDL) with 4ch AE monitoring was developed to investigate the thermal stress fracture behavior in SiC/SiC composites. The nucleation time and location of microdamages due to thermal stress were well detected by AE monitoring. (D4:2)

Toward a Virtual Material for Lifetime Prediction of CMCs
M Genet, G Lubineau (CNRS), P Ladevèze (CNRS/EADS)
A first step toward a multi-scale and multi-physic model - a virtual material - for self-healing ceramic matrix composites is presented. Each mechanism - mechanical, chemical - that act on the material’s lifetime at a given scale - fibre, yarn - is introduced in a single modeling framework, aimed at providing powerful prediction tools. (D4:3)

A Finite Element Model to Predict Multi-Axial Stress-Strain Response of Ceramic Matrix Composites with Strain Induced Damage
D Zhang, DR Hayhurst (Univ of Manchester)
Strain induced damage modes and their interactions are modelled using the finite element method for CMC tows and 0º/90º laminates. For both situations, bi-axial straining is addressed, together with the degradation of Young’s moduli and Poisson’s ratios. In all cases, the expected stress-strain behaviour is predicted. (D4:4)

Stress Redistribution around Notches in CVI C-SiC Composites
W Xiong, G-Q Jiao (Northwestern Polytechnical Univ)
The effect of nonlinear stress-strain behavior due to matrix cracking on stress redistribution around notches in CVI C/SiC composites laminate is analyzed. A constitutive model is developed and used to predict strain development around notches. The results indicate that both shear damage band and the tensile inelastic deformation contribute to the notch insensitivity of CVI C/SiC composite. (D4:5)

Transverse Multicracking of Tows in Woven CMCs: from Observations to Virtual Testing
P Pineau, J Lamon, G Couegnat (LCTS)
The present paper develops the method of virtual testing to investigate the local response of tows in a Ceramic Matrix Composite (CMC) under various loading conditions. The tows contain a matrix with voids and fibres which act as stress concentrators in the transverse direction. The mesh is constructed from a micrograph. (D4:6)
Thermomechanical and Fatigue Testing of Ceramic Matrix Composites (CMCs) in Combustion Environment using a Unique Combustion Materials Test Facility
T Kim, L Zawada (US AFRL) S Mall (US Air Force IoT)
This study characterizes fatigue properties and oxidation degradation of two SiC/BN/SiC CMCs with Syrlamic-based fibers in a set combustion condition facilitated by the AFIT/AFRL Burner Rig used to simulate typical engine hot section service environment. The two CMCs differing by the existence of in-situ BN fiber coating exhibited different results. (D4:7)

Effect of Impregnation of Pitch-Derived Carbon Composites with Polysiloxane-based Preceram on their Microstructure, Mechanical Properties and Oxidation Resistance
T Gumula, S Blazewicz, D Mikociak (UCI/AGH) J Michalowski (IFJ)
New pitch-based C/C composites were obtained from domestic pitches. These composites were impregnated with different polysiloxane-based solutions of preceram and subjected to heat treatment up to 1700°C. Microstructure, mechanical properties and oxidation resistance of the composites were investigated. (D4:8)

Thermal Shock and Oxidation Resistant Gradient Coating based on Yttrium Silicate for C/SiC Composite
X Zheng, Y Du, W Zhang (National Univ of Defense Tech)
A novel yttrium silicate coating system is designed and fabricated by microwave sintering. BAS glass is adopted as the sintering additive to decrease the sintering temperature and make the coating denser, and celsian enhances the high temperature resistance. Green tape is firstly used to get homogenous coating with designed thickness on components. (D4:9)

Multilayer Sic-Mosi2 Composites Produced by Tape Casting
A Antonini, S Biamino, M Pavese, P Fino, C Badini (Politecnico di Torino)
The study presents the results of the analysis of SiC-MoSi2 composites with multilayer structure produced by tape casting. The effect of different content of SiC and MoSi2 was investigated, as well as the result of alternating composite and SiC layers. The practicability of a Functionally Graded Material production was also considered. (D4:10)

Shape Transformation and Total Dissolution of Metallic Nanoparticles in Glass by Strong Electric Fields
G Seifert, H Graener, S Wackerow, A Stalmashonak (Martin-Luther-Univ)
Silver nanoparticles embedded in glass were transformed to ellipsoidal shapes by ultrashort laser pulses; applying strong dc electric field, the particles could also be dissolved leaving nanovoids in the matrix. The key processes at the glass-metal interface and the application potential of the techniques are discussed. (D4:11)

Microstructure and Mechanical Strength of Vacuum Brazing Bonded Ti3SiC2 Joints using Al Interlayer
L Shi, Y Zhong, J Yu, X He (HIT)
Ti3SiC2 is one of the nanolayered ternary ceramics Mn+1AXn, where M is a transition metal, A is an A-group (mostly IIIA or IVA) element, and X is C or N. It possesses a unique combination of the merits of both metals and ceramics. (D4:12)

SiC-ZrB2 Fiber-Reinforced Composites Prepared by Spark Plasma Sintering
SH Lee, HD Kim (KIMS) Y Kagawa (Univ of Tokyo)
Continuous SiC fiber-ZrB2 matrix composites were prepared. The ZrB2 matrix could be densified at 1600 oC by the application of MoSi2, B4C and C additives. The composites became brittle when the sintering temperature was at or above 1700 oC because of the damage of the BN coating and the SiC fiber. (ID4:1)
Static dissipative biopolymer composites for electronic packaging
W. Prissanaroon-Ouajai, S. Ouajai and A. Reung-u-rai
(King Mongkut’s Univ of Technology N Bangkok) Static dissipative biopolymer composites have
been prepared by adding conducting polypyrrole nanoparticles into poly(lactic acid) (PLA).
Poly(ethylene glycol) has been added to the composites in order to improve the dispersion of polypyrrole nanoparticles in PLA matrix. Resistivity of the composites is in the electrostatic
discharge (ESD) protection range, offering potential in electronic packaging applications where ESD is a major concern. (ID4:2)