Mechanical properties evaluation for thin film/substrate material systems

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Thin film/substrate material systems have been widely used in various industries such as aerospace, automotive, marine and electronics. One example is thermal barrier coatings (TBCs): TBCs are extensively applied to metallic components on gas turbine engines in order to protect them from high and prolonged heat loads, and they play an essential role in the aircraft industry. Another example is laminated polymer matrix composites (PMCs), reinforced with fibers such as carbon, glass or aramid: These materials have been extensively employed in a variety of applications due to their superior properties and the improving ease and cost-effectiveness of fabricating them. The evaluation of mechanical properties for thin film/substrate material systems is imperative for more efficient use of these material systems and further improvements.

In order to report the recent developments in the evaluation of the mechanical properties of thin film/substrate material systems, it is our great pleasure to present five papers in this special issue, titled "Mechanical properties evaluation for thin film/substrate material systems".

Regarding the mechanical properties evaluation of TBCs, Zhu et al. [1] propose a modified three-point bending test method to initiate and propagate an interfacial crack between the topcoat (TC) and bond coat (BC). Using the proposed method, only a single interface crack can be generated. The adhesion toughness of the TC/BC interface can be determined with a good repeatability. The method can be used for the evaluation of interfacial fracture toughness in TBCs and other multi-layer structures. Yuan et al. [2] studied the spallation behavior of TBCs on aero-engine turbine blades, manufactured by the electron-beam physical vapor deposition technique (EB-PVD). It was found that blisters in these TBCs can nucleate far below the conventional buckling radius and then grow and finally spall off, all at constant compressive residual stress and at constant room temperature, having cooled from elevated temperature. The experimental work clearly demonstrates that the spallation of EB-PVD TBCs is driven by pockets of energy concentration (PECs), which is recognized as a new spallation failure mechanism.

Fan and Xie [3] developed an etched-SiO-film grating fabrication technique based on solute-solvent separation soft lithography. The experimental results verify that the grating fabrication technique can be used to fabricate high-frequency gratings on TBCs for high-temperature applications. The gratings have strong oxidation resistance within 1000°C. They are also suitable to be used for inhomogeneous deformation measurement. Yin et al. [4] presented a study in which the microstructure of TBCs is designed and fabricated in order to enhance the thermal insulation effect. The simulation results show that the designed microstructure can significantly prolong the thermal balance time of TBCs, with an improvement more than 50% compared to traditional TBC structures. Furthermore, the insulation temperature between the heating surface and lower surface of the substrate is able to exceed 300°C, which is a significant improvement of more than 110°C compared to TBCs without the designed microstructure.

Acharya et al. [5] studied ultrathin ZnS films deposited on SiO_2 substrates via atomic layer deposition (ALD) using high-resolution X-ray photoluminescence spectroscopy (XPS) and attempted to elucidate the chemical species deriving from this metal-oxide to metal-sulfide transition. They have shown that an intermediate sulphate is formed upon the exposure of SiO_2 to the initial cycles of ALD ZnS deposition but rule out the formation of this species resulting from the sample's exposure to air.

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Simon S. Wang is an academic Professor in the Department of Aeronautical and Automotive Engineering at Loughborough University in UK, and in the School of Mechanical and Equipment Engineering at Hebei University of Engineering in China. He received his BEng degree from Tsinghua University in China in 1982 and his PhD degree from Birmingham University in UK in 1990. His earlier research work focused on developing accurate and efficient numerical methods for the mechanical analysis of plate and shell structures made from fibre-reinforced laminated composite materials. The mechanical problems included hyper-sonic aero-dynamic flutter, parametric resonance, impact response, vibration and vibration control, buckling, post-buckling and failure. His current research focuses on the mechanics of interface fracture in layered materials including macroscopic fiber

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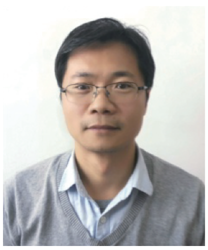
reinforced laminates, microscopic multilayer thin films, nanoscale multilayer graphene membranes and thermal barrier coatings.

Simon S. Wang
Department of Aeronautical and Automotive Engineering, Loughborough University, Loughborough, LE11 3TU, UK



Zhanwei Liu is a Professor in the School of Aerospace Engineering at Beijing Institute of Technology in China. He received his PhD degree from Tsinghua University in China in 2005. From September 2008 to August 2010, he worked as a Marie Curie Fellow in the Non-Destructive Testing (NDT) Validation Centre at The Welding Institute (TWI) in the UK. His research mainly focuses on developing advanced optical measurement methods, techniques and systems in the fields of Experimental Mechanics and NDT. His recent awards include the Technological Invention Award (1st Prize) by Ministry of Education of China in 2008 (ranking 4th), Program for New Century Excellent Talents in University in 2012, and the Natural Science Award (2nd Prize) by Ministry of Education of China in 2014 (ranking 3th).

Zhanwei Liu
School of Aerospace Engineering, Beijing Institute of Technology, Beijing, 100081, China

Christopher M. Harvey is a Senior Lecturer in the Department of Aeronautical and Automotive Engineering at Loughborough University in the UK. He received his MEng degree in Aeronautical Engineering from Loughborough University in 2009, followed by his PhD from Loughborough University in 2012. Immediately following his PhD, he was employed as Lecturer in Structural Mechanics at Loughborough University in the Department of Aeronautical and Automotive Engineering. Then in 2017 he was promoted to Senior Lecturer. He is also Programme Director of Aeronautical Engineering Undergraduate Courses, and has been since 2016. At present, his major research interests include the analytical, numerical and experimental aspects of interface fractures in layered materials including macroscopic fiber reinforced laminates, microscopic multilayer thin films, nanoscale multilayer graphene membranes and thermal barrier coatings.

Christopher M. Harvey
Department of Aeronautical and Automotive Engineering, Loughborough University, Loughborough, LE11 3TU, UK

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