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CMAS DEGRADATION AND IMPLICATIONS FOR COATING DESIGN

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Degradation of high temperature coatings by siliceous deposits generically known as CMAS is recognized as a fundamental barrier to progress in gas turbine technology. In principle, melting of the silicate deposit (at ~1200°C) limits the temperature capability of the coatings and thus the achievable engine efficiency. Molten CMAS dissolves all coatings of interest for superalloys and ceramic composites, often leading to the formation of new or modified crystalline phases, and can penetrate grain boundaries and the pore architecture of TBCs that enables tolerance of thermal strains. However, the chemical interactions may also be tailored for mitigation of the problem, usually by formation of surface layers of reaction products that limit further contact between melt and coating. To be useful, these modified surface layers must be tolerant of the stresses arising from the thermal gradients and cycles involved in engine operation. Developing solutions to this problem requires a sound understanding of (a) the underlying phase relations in the relevant systems, for which there is limited thermodynamic information, (b) the kinetics of dissolution and precipitation of reaction products, and its interplay with the dynamics of melt flow into the capillary passages and/or grain boundaries of the coating, (c) the stresses arising in the systems under severe and rapidly changing thermal gradients. This presentation will review recent developments in the fundamental understanding of the thermochemical and thermomechanical processes relevant to CMAS damage and mitigation, as well as the challenges in finding an adequate solution.

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