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This paper reviews the role of ceramic coatings technology in the hot sections of modern gas turbine engines by contrasting the role of surface engineering and coatings away from secondary reliance (i.e. the coating extending the life of the component and when the coating is lost or fails there is still an appreciable remnant life of the component) to prime reliance where the failure of the coating would result in a rapid failure of the component. To illustrate this change in design philosophy, the coating systems deployed in the HP turbine module in both shrouded and unshrouded configurations are discussed by comparing the performance of first and second generation coating systems.

Following the introduction of electron-beam physical vapour deposited (EB-PVD) zirconia partially stabilised with yttria (PYSZ) on the high pressure turbine blade in the early 1990's, a second generation low thermal conductivity coating was developed which successfully reduced the thermal conductivity of the coating by blocking electro-magnetic radiation in the infrared region and introducing mass and strain scattering centres in the lattice, reducing the amount of cooling flow to achieve a given component life. These ceramic alloying developments and optimisation of the low thermal conductivity coating are discussed along with a detailed understanding of the degradation and failure mechanisms in a range of laboratory/engine environments which included foreign object damage, CMAS simulation, erosion and probabilistic lifing.

In the development of future shroudless turbines, the adoption of advanced coating systems have successfully overcome the limiting factors associated with first-generation PYSZ materials of a relatively low sintering temperature (1200C) and elevated surface temperatures driven by the low thermal conductivity associated with thick coatings when used as abradable seals. The process optimisation and failure mechanism work on these new coating systems is discussed which combine an improved high temperature capability and a high resistance to thermal cyclic loading with good erosion behaviour, abradability and rub compatibility with the abrasive tip coating.

Looking forward, one of the key roles for surface engineering will be in supporting the integration of composite materials into the high pressure turbine by designing the ultimate in prime reliant protective coating systems. This paper concludes by briefly reviewing some of the strategies and technologies that will need to be developed to manage the protection of composite components in advanced engines.