Requirements for High Temperature Materials and Coatings in Future Energy Systems with Growing Contribution of Renewable Energy Generation

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Abstract:

Industrial gas turbines as well as coal fired power plants have been developed in past to increase efficiency as high as possible. This is still an important requirement in future for aircraft engines, to reduce emissions as well as fuel consumption.

For electricity production with high priorities for renewable energy sources, power plants have to be designed in future with high load flexibility ranging from 10 to 100 % as well as for frequent fast start up and shut down capabilities. This requires new and better bond coatings as well as new TBC systems with higher temperature capability and corrosion resistance for industrial gas turbines. Prediction of corrosion mechanisms as well as degradation by interdiffusion becomes an important issue to predict lifetime of components and protective coatings

The first part of the presentation will address the influence of thermal cycling conditions on TBC and bond coat lifetime, which strongly depends on holding time and temperature cycles. Ductile-Brittle Transition Temperature (DBTT) seems to play an important role on TBC failure. The second part will be concentrated on prediction of bond coat degradation by interdiffusion and oxidation with different composition. Incorporation into this model of hot corrosion prediction requires simulation of alkali deposit formation as function of fuel composition, air quality as well as operation conditions.

The second part addresses prediction of corrosive deposits on GT blading as a function of alkali and sulfur impurities and GT operation parameters, which are important for current and future operation of GT overlay coatings.

The last part is focused on the current state of the art to predict coating degradation by oxidation and interdiffusion with nickel base superalloys using modified Thermocalc and Dictra based simulation techniques, which require higher computation power and time compared with Calphad based simulation techniques to predict thermodynamic equilibria.