# OPTICAL EMISSION SPECTROSCOPY FOR RATE AND COMPOSITION CONTROL OF PLASMA-ASSISTED EBPVD PROCESSES

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Currently, EB-PVD of YSZ layers is the standard process for TBC on turbine components. Due to the similar vapor pressures of yttria and zirconia, processing is relatively uncomplicated, and the good performance of this material in various aspects is not easy to beat. However, the increasing need for enhanced turbine efficiency and reduced emissions requires new approaches and developments. This calls for improved TBC systems or ceramic-based turbine components coated with EBC systems, which go hand in hand with the use of new admixed materials and more complex coating compositions. Consequently, the corresponding PVD processes become more challenging as well and should be aided by enhanced monitoring and control means therefore.

Plasma activation of various PVD processes has been shown to be key to success in order to combine high-rate film growth with the requested film properties. The vapor and the reactive gas species are excited, ionized, and dissociated. The energy of charged particles impinging the substrate surface can be tuned resulting in layers with desired density, composition, hardness, or microstructure. The effect of plasma activation by using a hollow cathode arc discharge onto the morphology of YSZ layers [1,2] and its potential for coating of dense EBC's [3] have been discussed previously.

In this paper, another aspect of utilizing a plasma discharge in the vapor cloud will be discussed. Due to excitation of neutrals and ions, element-specific light emission occurs which can be analyzed by optical emission spectroscopy (OES). The spectrum can be used to monitor and control the PVD process. As an example, YSZ has been evaporated by EB-PVD, and an emission line of excited zirconium neutrals has been used to maintain a constant deposition rate. Moreover, metallic zirconium and yttrium have been co-evaporated in oxygen atmosphere by spotless arc-assisted EB-PVD [4], and the vapor species have been monitored by OES. In another project, co-evaporation of several metallic ingots has been performed by the jumping beam method, and an OES-based control loop is being developed to automatically control the EB power input and feeding speed of the individual ingots. This plasma-based OES control method has a considerable potential for the development of reliable, well-defined deposition processes. In addition, the co-evaporation approach may be of increased interest to deposit new complex TBC and EBC systems.

[1] G. Mattausch *et al.*: 55th SVC Annual Technical Conference Proceedings, 179-185 (2012)
[2] B. Zimmermann *et al.*: Poster presentation at ECI Thermal Barrier Coatings IV, Irsee, Germany (2014)
[3] B. Zimmermann *et al.*: Poster presentation at ECI Advanced Ceramic Matrix Composites, Santa Fe, USA (2017)
[4] B. Scheffel *et al.*: Surface & Coatings Technology 316, 155–161 (2017)