LaAlO3-based topcoats for novel thermal barrier coatings deposited by means solution precursor thermal spraying

E. Georgiopoulos[1], E. Marathoniti[2], N. Vourdas[2], C. Andreouli[1], V. Stathopoulos[2]

[1] MIRTEC S.A, 72nd km Athens- Lamia National Road, P.O. Box 146, 34100, Chalkida, Greece.
[2]School of Technological Applications, Technological Educational Institute of Sterea Ellada, 34400 Psahna, Chalkida, Greece

Turbine engine units are still the prime mover not only in power generation but also in aerospace and marine propulsion [1]. A particular aspect strongly affecting their lifetime, is related to the thermal barrier coatings (TBCs), which are used to protect and insulate the metallic gas turbine engine component from the hot gas stream, against high temperature corrosion, and subsequent damage. Improvement in this field may facilitate higher combustion temperatures and improved engine efficiency.

A typical TBC consists of a bondcoat, and a topcoat layer, and a thermally grown oxide (TGO) which evolves gradually during deposition and operation. The top coat of a conventional TBC consists of a 6-8 wt% Yttria-stabilized ZrO_2 (YSZ) and is deposited either by Atmospheric Plasma Spray (APS) or by Electron Beam Physical Vapor Deposition (EB-PVD). However, extreme operating temperatures (over 1200 °C) as well as repeated thermal cycling create stresses and finally limit the durability of the coatings in service. Higher service temperatures entail the development of novel TBC systems using innovative materials and processes, exhibiting behaviour according to the pertaining specifications, in terms of melting point, thermal conductivity, thermal expansion coefficient (TEC), microhardness, thermal shock resistance, mechanical properties (strength, wear), microstructure, thermal and chemical stability, phase transitions as well as environmental restrictions and economic aspects [2-4].

This has been pursuit, partially, through the development of nano-sized agglomerated particles along with the emergence of new thermal spray processes such as Solution Plasma Spray (SPS) [5].

Particles of several materials have been investigated, such as pyrochlores, doped zirconia, aluminates [6, 7] and perovskites (ABO_3) [8-11], rare-earth perovskites in particular [8-15]. $Ba(Mg_{1/3}Ta_{2/3})O_3$ (BMT) and $La(Al_{1/4}Mg_{1/2}Ta_{1/4})O_3$ (LAMT) exhibiting low thermal conductivity (~2 $Wm^{-1}K^{-1}$) and high thermal expansion coefficient TEC (~11 10^{-6} K^{-1}) have shown promising results as YSZ alternatives, after APS depositions.

SPS, or solution precursor thermal spray (SPTS) deposition technique has attracted much attention, due to its versatility in delivering coatings with controlled microstructure and graded profiles in a single step [5].

In this study we present the development of $LaAlO_3$ coatings for TBC applications, by means of SPTS. $LaAlO_3$ precursor solutions have been synthesized followed the *in situ* polymerization with citric acid [16-17]. The details of the solution synthesis, and deposition method, along with characterization of the deposits by means of Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD) analysis, and microhardness measurements is reported. The effect of critical plasma spray deposition parameters on the resulting microstructural characteristics and phase composition of the developed coatings is discussed.

References

[1] N. P. Padture, M. Gell, and E. H. Jordan, Science **296** (5566), 280 (2002).
[2] R. Vaßen *et al.*, Surface and Coatings Technology **205** (4), 938 (2010).
[3] D. R. Clarke, M. Oechsner, and N. P. Padture, MRS Bulletin **37** (10), 891 (2012).
[4] L. Pawlowski, Surface and Coatings Technology **202** (18), 4318 (2008).
[5] C. Monterrubio-Badillo *et al.*, Surface and Coatings Technology **200** (12–13), 3743 (2006).
[6] K.L. Ovanesyan *et al.* Journal of Contemporary Physics (Armenian Academy of Sciences), **49** 220 (2014).
[7] A. V. Yeganyan *et al.* Journal of Contemporary Physics (Armenian Academy of Sciences), **49** 176 (2014).
[8] R. Vassen *et al.*, Journal of American Ceramic Society **83** (8), 2023 (2000).
[9] G. Mauer *et al.*, Journal of Thermal Spray Technology **22** (5), 646 (2013).
[10] V. Stathopoulos *et al.* Reaction Kinetics and Catalysis Letters, **72** 49 (2001).
[11] V. Stathopoulos *et al.* Reaction Kinetics and Catalysis Letters, **72** 43 (2001).
[12] X. Q. Cao, R. Vassen, and D. Stoever, Journal of the European Ceramic Society **24** (1), 1 (2004).
[13] W. Ma *et al.*, Journal of Thermal Spray Technology **17** (5-6), 831 (2008).
[14] M. O. Jarligo *et al.*, Journal of Thermal Spray Technology **18** (2), 187 (2009).
[15] M. O. Jarligo *et al.*, Journal of Thermal Spray Technology **19** (1-2), 303 (2009).
[16] M. Kakihana, and T. Okubo, Journal of Alloys and Compounds **266** 129 (1998)
[17] H. Gasparyan *et al.,* Solid State Ionics, **192** 158 (2011)