Fabrication of thick, crack-free quasicrystalline Al–Cu–Fe coatings by electron-beam deposition

S. Polishchuk, A. Ustinov, V. Telychko, A. Merstallinger, G. Mozdzen, T. Melnichenko

PII: S0257-8972(16)30127-X
DOI: doi: 10.1016/j.surfcoat.2016.03.002
Reference: SCT 20975

To appear in: *Surface & Coatings Technology*

Received date: 13 November 2015
Revised date: 5 February 2016
Accepted date: 2 March 2016

Please cite this article as: S. Polishchuk, A. Ustinov, V. Telychko, A. Merstallinger, G. Mozdzen, T. Melnichenko, Fabrication of thick, crack-free quasicrystalline Al–Cu–Fe coatings by electron-beam deposition, *Surface & Coatings Technology* (2016), doi: 10.1016/j.surfcoat.2016.03.002

Fabrication of thick, crack-free quasicrystalline Al–Cu–Fecoatings by electron-beam deposition

S. Polishchuk[(1)], A. Ustinov[(2)], V. Telychko[(2)], A. Merstallinger[(3)], G. Mozdzen[(3)], T. Melnichenko[(2)]

[1]*G.V. Kurdyumov Institute for Metal Physics, 36 Vernadsky str. 03142 Kyiv, Ukraine*
[2]*E.O.Paton Electric Welding Institute, 68 Gorky str. 03150 Kyiv, Ukraine*
[3]*ARC Seibersdorf Research, A-2444 Seibersdorf, Austria*

Abstract

Quasicrystalline Al-Cu-Fe coatings have been fabricated using electron-beam physical vapour deposition (EBPVD) at substrate temperatures in the 570-890 K range. The structure of some coatings deposited in that way contains defects, like channel cracks. It is shown that residual stresses developed during coatings cooling to room temperature may lead to the channel cracking in the coatings. X-ray diffraction analysis has demonstrated that residual stresses in the crack-free Al-Cu-Fe coatings increase linearly with deposition temperature, which is caused by the rise of thermal stresses due to the difference in thermal expansion coefficients of the coating and substrate material.

The analysis of the residual stresses dependence on the deposition temperature has enabled the thermal expansion coefficient of the coating material to be determined at $\alpha_c=(17.1\pm1.3)*10^{-6}\,K^{-1}$.The fracture toughness of the coating material in terms of the stress intensity factor has been estimated at $K_{1C}=1.68\pm0.11 MPa\sqrt{m}$. These characteristics of the Al-Cu-Fe coatings obtained have been used for the calculation of a critical thickness, below which the crack-free structure of the coatings is retained.The obtained values of the critical thickness were compared with the results of experimental study of surfaces of the Al-Cu-Fe coatings deposited onto different substrates at various temperatures. We observed that the channel cracking was inhibited if the coating was thinner than the corresponding critical thickness.

Keywords: Quasicrystal; PVD thick coatings; Residual stress; Cracking; Critical thickness