SUMMARY

Author: Tadeusz Kubaszek

Title: **Porosity and deposition efficiency - criteria for the selection of ceramic layer ZrO_2 x n Y_2O_3 thermal spraying parameters for the thermal barrier coating applied in the hot section part of jet engine**

In the research parameters of the air plasma spraying process (APS) was determined for the ceramic layer of the thermal barrier coatings deposited with micro- and nanopowders of ZrO_2 for established porosity and deposition efficiency criteria. The dissertation thesis was that it is possible to deposit ceramic coatings with expected physical properties - porosity and thickness, using ZrO_2 x $8Y_2O_3$ oxide micro- (<10 μm) and nanopowders(<1 μm) in the APS process with high deposition efficiency, taking into account their application as an outer layer of thermal barrier coatings used in the hot section part of jet engines.

The thermal and physical properties of particles moving in the plasma plume (their temperature and velocity), the feed method of the particles into the plasma plume (radial and axial) as well as the parameters of the spraying process (current, plasma gases' flow rate) were considered in the research. Their influence on the chemical and phase composition, the morphology of the microstructure and properties of the coatings were determined. The process conditions were developed based on thermal and physical properties of particles moving in the plasma plume – temperature and velocity. In the microscopic examination, the porosity and thickness of the deposited ceramic layer of thermal barrier coatings were verified.

The research covered an analysis of the APS plasma spraying conditions (the hydrogen flow rate and the current) influence on the thickness and porosity of the produced ceramic layer of the thermal barrier coating. The parameters of the ceramic layers' deposition were determined for using micro- and nanopowder D50 = 5 μm (Metco 6700) and D50 <1 μm (Metco 6609), as well as radial (A60 single-electrode plasma torch) and axial (Axial III three-electrode plasma torch) feed of the particles into the plasma plume.

It was found that all ceramic layers had a lamellar structure. It was established that changing the feed method of micro- and nanopowders particles into the plasma plume - from radial to axial, and increasing the flow rate of plasma gases and the current of the Axial III torch influenced the high energy of these particles. It also reduces the pore diameter of the ceramic layer and its porosity. For the developed APS process parameters and the micro- and nanopowders used, the Zr, Y and O in the outer ceramic layer and Ni, Cr, Al, Co and Y in the metallic interlayer were found. The presence of crystallites of the $(ZrO_2)_{0.96}$x $(Y_2O_3)_{0.04}$ phase with a tetragonal structure and the polymorphic form of the ZrO_2 oxide with a monoclinic structure (M phase) was also found in the ceramic layer. The analysis of thermal properties showed similar thermal conductivity of the thermal barrier coatings, regardless of the particle diameter of the ZrO_2 x $8Y_2O_3$ oxide powder used in the APS process. The ceramic layer deposit from ZrO_2 x $8Y_2O_3$ oxide nanopowder D50 <1 μm (Metco 6609) axially feed into the plasma plume (Axial III) had the highest resistance to high-temperature oxidation. The research also found that this ceramic layer is characterized by good adhesion to the substrate, similar to the standard powder with an average diameter D50 = 66 μm (Metco 204NS). The axial feed of the powder particles into the plasma plume (Axial III) enables an increase in deposition efficiency of the APS process, as well as a reduction in the costs of ceramic layers' deposition for thermal barrier coatings used in the hot section part of jet engines.

Keywords: thermal barrier coatings, air plasma spraying process APS, ZrO_2 x nY_2O_3 oxide micro- and nanopowders