DESCRIPTION FOR THE GENERAL PUBLIC

TiAl alloys are very promising construction materials especially for aircraft engine components due to a beneficial relation between their specific mass and strength. Some of them have recently been tested as an alternative for the currently applied heavy nickel alloys. Lowering the mass of components is of significant importance in the aircraft industry. A fundamental drawback of these alloys is their low resistance to aggressive gases at high temperatures thus they need to be protected with appropriate coatings. New production processes will allow in the future to construct thin walled components which creates the necessity for the application of Thermal Barrier Coatings (TBCs). There is a lack of data concerning the fundamentals of physicochemical phenomena which take place during the deposition of bondcoatings and ceramic coatings on ɣ-TiAl alloys. There is little information on the phenomena and degradation mechanisms of these coatings at high temperatures and their interaction with the substrate alloy under mechanical loading.

This subject will be performed under the BEETHOVEN II programme between two Polish and two German institutions perfectly complementary in terms of both the equipment for producing the coatings and scientific achievements.

The justification for a joint research initiative which is the subject of the project is a very good experience of the German Aerospace Center (DLR) in the manufacturing of ceramic coatings and the methodology for testing of coatings under mechanical loads of Karlsruhe Institute of Technology (KIT) while on Polish site the Silesian University of Technology (SUT) has well developed methods for deposition of diffusion coatings aided by the excellent and state of the art investigative equipment operated at the Institute for Ferrous Metallurgy (IFM). The need for cooperation results from the lack of sufficient knowledge on the phenomena taking place during the processes of surface modification and degradation of coatings on ɣ-TiAl alloys.

The aim of the project are research works on a complex coating model consisting of a AlSi bondcoating deposited by diffusion process in active gases (CVD). The surface of the coating will be modified in order to obtain a special bonding layer on which a ceramic top coating will be deposited using electron beam physical vapor deposition method. One of the major issues to resolve will be the development of physicochemical basics for the deposition of a diffusion AlSi coating by CVD at temperatures around 850 ˚C – 900 ˚C as well as formation of aluminum oxide on its surface.

An important goal of the project within tasks performed on the German site will be the development of fundamentals for the deposition of AlSi and TiAlCrY coatings by magnetron sputtering method. It is based on physical processes of coating deposition guarantees a high purity level as well as the possibility of eliminating the influence of substrates chemical composition on the microstructure and properties of the coating. The basics for physical deposition of these coatings as well as the influence of parameters on their microstructure and specific characteristics of the surface on which the stable Al_2O_3 oxide scale will be formed.

The fundamental advantage of this method is the low temperature of deposition which is of great importance for ɣ-TiAl alloys and the possibility to tailor a wide range of the chemical composition of the coatings. The coatings produced within the project according to the following model: diffusion bondcoating – modified surface – ceramic top coating will be subject to detailed analysis of micro- and substructure using state of the art electron microscopy techniques. The gained knowledge will allow for a hitherto unknown description of the coatings for ɣ-TiAl alloys with modified surfaces.

The investigations on the influence of coatings under mechanical loading will allow for the explanation and acquisition of new knowledge on the degradation mechanisms of ɣ-TiAl alloys with coatings at high temperatures. Exceptionally interesting results will concern the brittle to ductile transition temperature of the coatings and their behavior under these conditions. The new knowledge obtained within the project will provide information concerning the fundamental phenomena occurring during surface modifications of ɣ-TiAl and their influence on its mechanical properties.