DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

The scientific objective of the project is complete and accurate model analysis determine both analytical and numercial approach and to verify using experimental data of heat gain by FeAl powder feedstock particles in a gas-detonation spraying (DGS) flow.

Achieving the intended goal requires a performing series of experimental studies to determine the thermodynamic state of the gaseous phase in the condition of gas-detonation process as well as thermo-physical properties of the feedstock powder materials and multiphase Fe-Al type intermetallic coatings with the participation of Al_2O_3 oxides.

Analysis of interdependences identified the basic phenomena of heat transfer between the FeAl particle and the gas flowing around as well as heat effects of FeAl phase transformations in the controlled DGS process conditions will allow to judge the issue of the state of the FeAl particles during the impact with the substrate. This is crucial for the formation of the intermetallic, multifunctional structure of the FeAl protective coating with promising exploitation properties for the power plant industries.

As a result of the experimental analysis plans to the analytical and numerical modeling of heat, mass and momentum transfer for the FeAl particle state evaluation, as well as the model dealing with the meta-stable solidification which is strongly deviated from the equilibrium will be performed to goal of the mechanism recognize of the micro-joint formation at the partial melting of the surface particles.

The micro-segregation model will be the universal one and it will include its equations of the extremely non-equilibrium solidification which leads even to the amorphous phase formation. Additionally, the model for the solute micro-segregation accompanying the rapid solidification will be also performed.

The formulation of a model theoretical description of the phenomenon, covering the exchange of momentum and convective heat transfer between the FeAl particle and the gas flowing around it will, when combined with experimental verification of model assumptions, allow one to give a more precise description of such important basic phenomena. It is, among others, analysing for the first time heat conduction in the volume of FeAl particles while taking into account the radiative effects of heat transfer between FeAl particles and the wall of detonation gun.

Elementary phenomena based on the comparison of the model-designated characteristic time values of: particles acceleration (τ_V), their convective heating (τ_T) and heat diffusion (τ_a) distinguished as part of basic studies will allow one to identify and confirm the presence of specific mechanisms for the exchange of energy in the experimentally carried out process of gas detonation spraying of FeAl type intermetallic feedstock material. Experimental verification of the model assumptions will be based on the results of structural studies of the coating material (chemical and phase composition, crystallographic and morphological micro-texture, as well as FeAl superlattice inheritance from the feedstock powder particles).

Although, specific studies will concern the FeAl powder particles, the elaborated modeling methodology, including analytical and numerical, will have be universal. It will enable complex analysis of the heat and mass transfer phenomena, as well as dynamic gas interactions of the detonation flux with any particles of powder feedstock materials, being a condensed suspension in a two-phase metallization supersonic flux.

In addition, the thermophysical properties of the heterogeneous multiphase structure of the intermetallic coating, as defined in elementary studies, will constitute a fundamental knowledge for the design of Fe-Al structure coating obtained with the DGS and HVOF supersonic stream but also plasma spraying (APS and VPS) and arc spraying.

Substantive concept, of the presented objectives, requires interdisciplinary experimental and numerical analysis (in thermodynamics, fluid mechanics, chemistry and solid state physics) using highly sophisticated research methods described in the summary of the project – point No. 2. It will include analysis of the behavior of the two phase metallization flux in the controlled technological conditions of the DGS process and its influence on the structure shaping and occurrence of the phase transition in the intermetallic FeAl protective coatings.

The measurable effect of these research and analyses will be general and fundamental knowledge with systematized database about consistent model of the analytical solutions and the numerical-simulation giving the opportunity to take attempt to optimize technological parameters in the DGS process as well as the structure properties of the Fe-Al type intermetallic coatings.

The final result of the project ,in utilitarian terms, it will offer to optimize of the multiphase Fe-Al coating with the mapping of the oxide Al_2O_3 phases formation which created cermetal structure type resistant to the effects of high temperature and the aggressive environment during heating in fluidized bed boiler, i.e. the Power Plant Zeran.