DESCRIPTION FOR THE GENERAL PUBLIC

The main scientific objective of the proposed project is to investigate and analyze the phenomena occurring during the process of remelting of plasma sprayed coatings made of Ni-Cr (as a model material) and several Ni-Cr-Re alloys with differential Re content (up to 40 wt.%). It is planned to apply two remelting technologies, i.e. using a focused laser or electron beam. The main advantage of remelting technology is the ability to obtain coatings characterized by a lack of porosity, higher hardness and wear resistance and better adhesion to the substrate material. So far, the phenomena occurring during remelting of coatings containing rhenium performed by high energy beams were not discussed in the world literature in detail. The main difficulty in a comprehensive description of such phenomena is the fact that the process of crystallization occurs in a nonequilibrium conditions. Moreover, successively remelted areas are subjected to thermal cycles (heat treatment) of the previously remelted regions. Therefore, the materials for spraying and remelting were selected in such a way that allows for studying various crystallization paths from the melt. The Ni-Cr alloy steel has been selected as a model material. Then, a series of Ni-Cr-Re alloys containing different content of Re will be subjected to the detailed investigations comprising the detailed characterization of microstructure and selected mechanical tests (hardness and microhardness, adhesive, wear resistance). The newly developed material for plasma sprayed coatings is a very interesting material from scientific point of view and may constitute a great potential for future applications.

The atmospheric plasma spraying (APS) is a highly efficient process, allowing for producing compact coatings, however, the investigations carried out so far have shown that the such coatings are characterized by relatively high porosity and numerous material discontinuities. For this reason, the remelting of plasma sprayed coatings if often necessary in order to remove these discontinuities. The remelting may be performed by several techniques. This research deals with two methods of remelting. Both of them utilize concentrated energy beams: photons, i.e. laser beam, and electrons. Though the applications of laser beams for remelting of plasma sprayed coatings are reported in the world literature, the knowledge of the application of an electron beam for this purpose is very limited. This process is carried out in a vacuum which additionally refine the liquid material. The blocking of oxygen access from the atmosphere lowers the oxygen level in the remelted coating. Thus, the idea of remelting of plasma sprayed coatings, especially of Ni-Cr-Re alloys, with laser or electron beams as heat sources, opens up a new research thread that is important to both scientific and manufacturing communities.

The significance of this research lies in the development of scientific foundations for the broader adaptation of remelting methods applied to plasma sprayed coatings that make use of high energy electron or laser beams. Producing of high quality wear resistance coatings constitute a great challenge both from scientific and practical point of view. It is believed that the program objectives advance the current knowledge base of phenomena occurring in metallic coatings containing rhenium additions. The proposed research program has a unique character and will contribute in a significant way to the body of knowledge regarding the phenomena occurring in alloys containing rhenium subjected to fast thermal cycles.