Popular-Science abstract:

Fabrication of intermetallic and metal-matrix-composite coatings allows to significantly improve the surface properties of substrate of materials and extend their application perspectives. One of industrially established coating deposition method is a plasma spraying. Its application ranges from thermal barrier coatings deposited on blades of jet engines turbines to cylinders in Volkswagen Lupo's engine. Comparing plasma spraying with other presently used industrial methods of coatings deposition shows the superiority of the former, i.e. other methods, such as electroplating or plasma spraying with high velocities, either do not provide sufficient adhesion of the layer or is not economically justified (Fig.1). New competitive deposition methods, capable to eliminate most of plasma spraying drawbacks at a reasonable overall cost of production, are constantly sought.

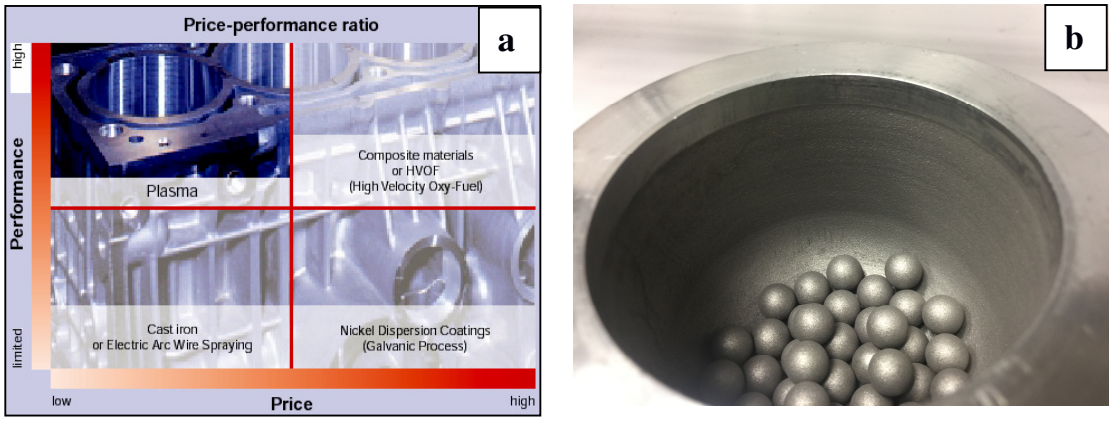

Fig. 1. The plot comparing the performance and cost of industrially applied deposition methods of coatings (a) and image presenting interior of vial used for ball milling coated with processed material (b).

A brand new method of deposition of tribological coatings, presented in this project, takes advantage of negative effects occurring during ball milling of alloys and composites, especially sticking and pressing of milled powders into walls of vials as well as heating of the system during the milling process. Simultaneously, it should be taken into account that these events occur in the beginning of powders milling process, what allows to accomplish the deposition process with ball milling in significantly shorter process times as conventional mechanical alloying (where the powder should be removed from the walls of vial after longer processing times). Simultaneously, one may point out that such coating could be deposited only on inner walls of cylinders.

Deposition of NiAl intermetallic coatings on metallic substrates may significantly improve their surface properties paving the way for many practical applications, especially in reducing their wear. The investigation of plasma-sprayed NiAl coatings showed that even better results are obtained after a certain quantity of CrB_2 ceramic phase was added. The addition of ceramic phase into intermetallic matrix redistributes loading in the intermetallic matrix simultaneously preserving the high-temperature properties of base intermetallic. The coatings obtained with newly proposed method of ball milling – as compared to plasma spraying – should be characterized by better adhesion, grain refinement, density, uniformity of ceramic phase distribution in NiAl matrix. Therefore, the main aim of the project is to undertake an attempt to deposit NiAl(CrB_2) composite coatings with the help of ball milling. Application of advanced microstructure investigation methods for present project i.e. scanning and transmission electron microscopy techniques should help to describe a mechanisms active during such deposition. Finally, the microhardness and wear tests will be carried out at room conditions and elevated temperatures to check the surface properties.

Practical applicability of such a method must be obviously evaluated by the industry in the future. However, at present stage, all the literature data from the mechanical alloying area documenting unwelcome sticking of the milled material to vial sides suggest that reversing the situation and using milling of metallic and ceramic powders for composite coatings deposition should be a success.