Review of the doctoral thesis
Reviewer: doc. Ing. Stanislava Fintová, Ph.D.

Doctoral thesis title: Advanced Plasma-Sprayed Ceramic Coatings Prepared from Liquid Feedstocks
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The proposed thesis is focused on the preparation and characterization of aluminum oxide-based coatings from liquid feedstocks using the plasma spraying technique. The author proposed the suspensions and solutions composition, optimized the deposition conditions, and determined the properties of the coatings in terms of microstructure, phase composition, hardness, wear resistance, and adhesion strength. Based on the obtained results, the addition of chromium oxides into the feedstock was performed by the author. Three different concepts of chromium addition employing intermixing suspensions of fine powders, intermixing solutions of chemical precursors, and hybrid spraying by simultaneous deposition of suspensions and dry coarse powders were proposed by the author resulting in various coatings with different properties.

The thesis is divided into a theoretical background, objectives, samples preparation and characterization methods, collection of papers, synthesis of results, and conclusions including further prospective. The theoretical part provides basic information about plasma spraying parameters and conditions, deposition process, and the used alumina oxide coatings. The part provides sufficient information about the process and alumina oxides. More attention could be paid to the structure and properties of the aluminum oxide-based coatings to provide the reader an idea before reading the results. Objectives of the thesis are followed by samples preparation and methodology description. Objectives are clear and well-formed providing a clear idea of the methodology. The used methods of the analysis are described in sufficient detail to repeat them. The results are presented in the form of a collection of papers and are divided into four parts according to the individual goals of the thesis. To each paper, a separate summary providing information about the goal and reached results are presented in the thesis. At the end of the thesis is a synthesis of results summarizing the work presented in the papers is given, following by the conclusions covering the main findings of the author within the scope of the presented thesis.

Topicality

Even though aluminum oxide is widely used within the thermal spraying industry for several decades, it is used in the form of dry coarse powders. The thesis brings novel findings allowing their usage in the form of suspensions and solutions including also hybrid spraying. Analysis of the influence of individual feedstocks and deposition conditions resulted in various structures and compositions of the coatings tailoring their properties.

For the theoretical background author used 78 references, while 34 were from the last decade and 12 from the last 5 years. On the other hand, a significantly higher number of recent publications were cited in the authors' papers published in impacted journals dedicated to the thesis presented as the results. This also indicates the importance of the topic in the scientific community.

Processing methods

The thesis is written in a readable form with clear statements. The used methods are described sufficiently to be reproduced and the provided conclusions are based on the results of the experiments.

Used methods are adequate to the goals of the study. Results obtained during the study are provided in the form of commented papers published in impacted papers and are also summarized in a separated section. Conclusions provide an overview on the most important findings of the author within the chosen topics.

Fulfillment of the objectives

The authors fulfilled set objectives.

The author set the composition of liquid feedstocks adequate for plasma spraying reaching coatings with appropriate properties. The addition of chromium into the alumina-bases liquid feedstock performed in several ways resulted in alumina α-phase content increase in the final coating and various coating properties.

Results/scientific contribution

Several custom-made suspensions were proposed by the author and the properties of the final coating were compared with the properties of the coating prepared from the commercial suspension. Changing the spraying parameters and suspensions composition, the variability of the process was shown. Some of the customized coatings reached improved properties comparing to the commercial one. The experiments showed that the feedstock type largely determines the final coating structure.

The addition of chromium oxides into the alumina was performed using intermixed suspensions of fine powders or hybrid spraying. Each method creates different coatings. Both methods, however, promoted the formation of the alumina α-phase. Using the intermixed precursor solutions incorporates chromium into the alumina crystal structure.

The author provided a comprehensive study focused on individual aspects of the preparation of alumina oxides-based coatings via plasma spraying from the liquid feedstock, which is not commonly used. New results obtained in the field will provide the basis for the additional research. The main application of the studied method can be seen in the coatings structure tailoring and different materials combinations as mentioned in the „Further prospective".

The student is the author of 9 publications collected in WoS and 22 in SCOPUS with 70 and 91 citations, respectively.

Questions for discussion:

1) What influence of the prepared coatings do you expect on the fatigue properties of the coated components (considering the coatings type, structure, and phase composition)?

2) In the thesis, you mentioned that PS alumina is besides other used also as high-temperature protection for heating elements in furnaces or steam pipes and walls in coal-fired boilers (page 25). Do you have any idea how would the structure of the prepared coatings (hard dense coatings, columnar cauliflower-like microstructures, and highly porous deposits) influence the high-temperature protection of the coatings?

3) How does the plasma spraying influence the substrate microstructure and properties?

4) Which one of the coatings is the best and which property/criterion is the most important according to your opinion?

I recommend the doctoral thesis for defense and after a successful defense, I recommend granting the title of Ph.D.

V Brně, 05.10.2021

doc. Ing. Stanislava Fintová, Ph.D.