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Report about Dissertation Thesis of Martin Daněk

The thesis presented by Ing. Martin Daněk, with title "*Design of wear resistant coatings for high temperature applications*", in the aim of the defense of his Ph. D. in Czech Technical University in Prague, is focused on the study of coatings for high temperature industrial applications.

The thesis is relevant to current needs of scientific community
In order to increase the lifetime of high-performance tools the author proposed the development of coatings by magnetron sputtering, using an industrial set-up. This approach is clearly very interesting for the scientific community.

The main objectives of work have been fulfilled
The objectives of the work, are the development of coatings for high-speed dry machining of hard steel and for high pressure die casting of aluminium. In order to accomplish these two objectives, the author presents the document separated in two sections. The first section reports the development of TiAlCrN coatings and the results presented shows that the Cr addition to TiAlN clearly can improve the oxidation resistance and this behaviour has a great impact on the dry drilling tests performed at high cutting speed. For the second section the author studied first the development different candidates for base layer in order to improve the adhesion as well as the a nitriding treatment and second the shield layer (coating) for high pressure die casting of aluminium. For coating optimization, the author studied the adhesion to aluminium by analysing the Cof against aluminium in room temperature; and also study the resistance against abrasive wear and molten aluminium corrosion at high temperature, performing sliding tests against alumina ball at 650°.
It is clear that the proposed objectives were achieved.

Methods used in the thesis have been appropriate
In order to characterize the deposited films the author used several Characterization Techniques, such as, SEM/EDS for morphology and for chemical composition analysis, TGA for thermal properties studies, nanoindentation for mechanical characterization, rockwell test for

cohesion/adhesion studies. He performed structural analysis by X-ray diffraction (XRD) and scanning electron microscopy (SEM) before and after thermal annealings in order to study the oxidation resistance. These techniques were used to investigate the film's microstructure and changes caused by the oxidation. In fact, these techniques were used for coatings characterization and also for wear track characterization. The author tried propose wear mechanisms and discuss tribological behaviour using the results obtained by these techniques, meaning that the methods used have been in general appropriated. At the end the candidate try to perform some real dry drilling tests and try to correlate with the fundamental characterization performed.

Main results and contributions of the work

The thesis presents several achievements:

i) This thesis clearly aims to understand the condition causing degradation of hard nitride coatings in high temperature environments

ii) This thesis develops an interesting numerical simulation model for the industrial set-up used (focused on the substrate holder versus the 4 cathodes used), in order to optimize a TiAlCrN multilayer structure growth.

iii) This thesis clearly focuses on the development of coatings for industrial applications in order to achieve products that can reach the market.

The work is important for the further development of science

This work is dedicated to the study of coatings for high temperature applications. It is well known that the development of coatings used for modern high-speed machining without the use of a cooling liquid is fundamental. The sustainability demands that the R&D activity be focused on the development of new materials for environmental protection. In this context, this work is clearly important for the science development.

What the thesis satisfies conditions of a creative scientific work

Yes, it is a rich work with interesting results with a creative and innovative approach, as it is supposed for a Ph. D Thesis.

Final decision

The author of the thesis proved to have ability to perform research and to achieve results, however he should be more scrupulous in the process of writing the final document. I still do recommend the thesis for presentation with the aim of receiving the Degree of Ph. D.

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