EMERGEMAT

3rd International Conference on Emerging Technologies in Materials Engineering
29-30 October 2020 - Bucharest, Romania

REVIEW ON THE DESIGN OF A MULTILAYER MATERIAL: NiCrAlY - Al_2O_3 DEPOSITED BY E-BEAM PROCESS ON AUSTENITIC 316L STAINLESS STEEL SUPPORT, WITH APPLICATIONS IN NUCLEAR INDUSTRY

Laurentiu MOSINOIU[1], Arcadii SOBEȚKII[1*], Mircea CORBAN[1], Alexandru Cristian MATEI [1], Daniel PETRESCU[2]

[1] National R&D Institute for Non-ferrous and Rare Metals – IMNR, Romania, arcadii@imnr.ro; [2] Institute for Nuclear Research Pitesti – ICN, Romania

ABSTRACT

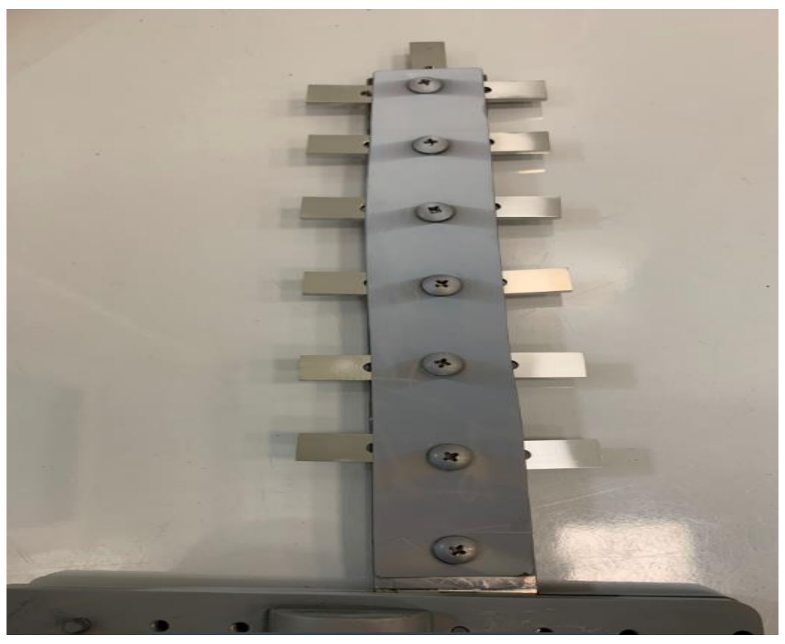
Iron-chromium-aluminium-nickel alloys, as well as 316L austenitic stainless steel, have good corrosion behavior and stability at high temperatures. Often prolonged exposure to temperatures of almost 700ºC in aggressive environments (eg. in boilers and furnaces, in nuclear installations) can cause problems leading to accelerated corrosion degradation. For this reason, efforts have been made worldwide to design new alloys to optimize Cr and Al levels. A known solution is to obtain coatings by forming an outer layer of Al_2O_3 that can provide excellent resistance to oxidation and corrosion.

Thus, we try to obtain ceramic coatings by electron beam evaporation technique with alloys based on Ni-Cr and Al_2O_3 on austenitic 316L stainless steel, obtained in different experimental conditions, which have a very good feasibility in various applications in nuclear industry.

OBJECTIVES

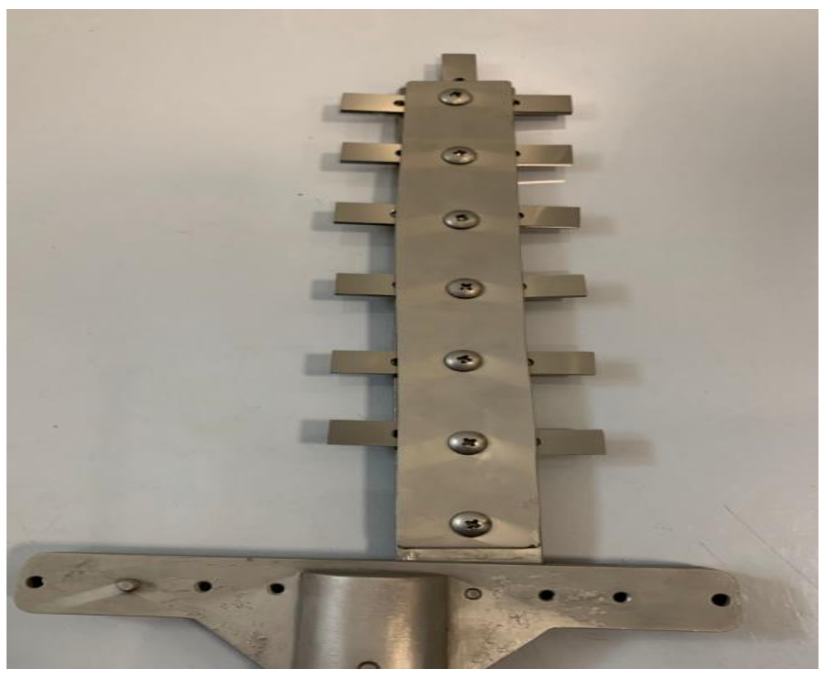
- Obtaining ceramic coatings by electron beam evaporation technique: EB-PVD / NiCrAlY and Al_2O_3 layers deposited on austenitic 316L stainless steel support;
- Characterization of materials deposited by EB-PVD: scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDX) and scratch test.

EXPERIMENT

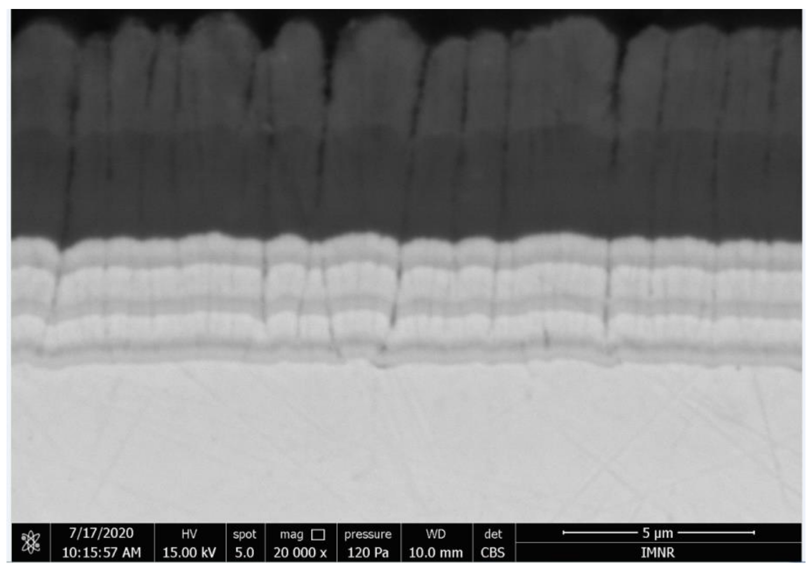


316L Austenitic stainless steel supports before electron beam deposition

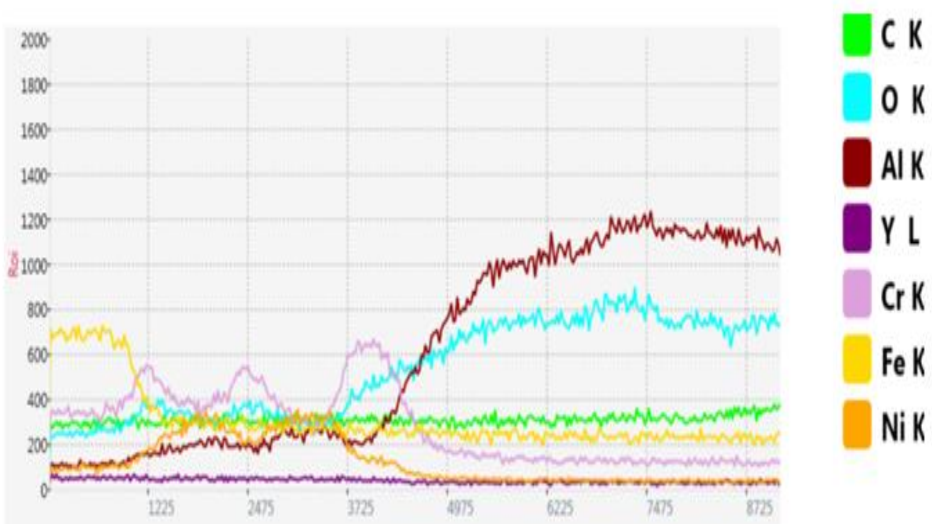
The Torr Int. Inc. e-beam evaporation equipment



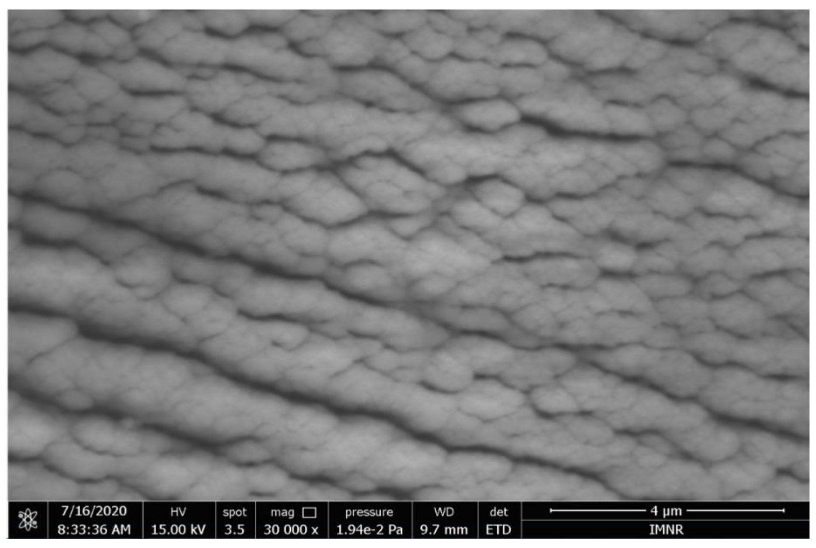
316L austenitic stainless steel supports after electron beam deposition



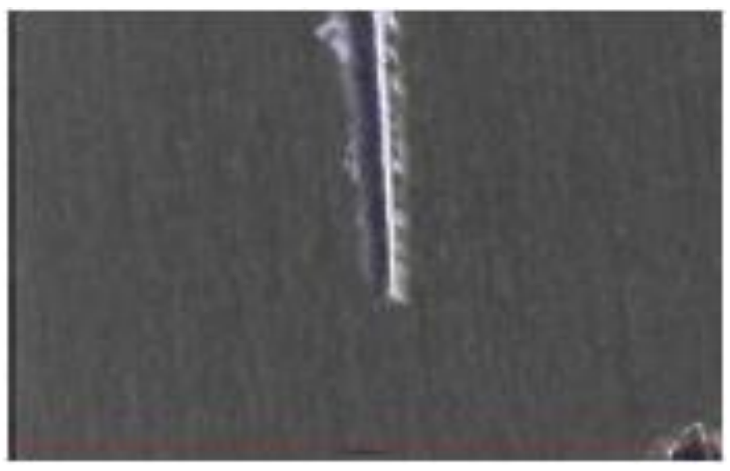
SEM microanalysis in section on 316L austenitic stainless steel sample covered by EB-PVD process with NiCrAlY and Al_2O_3

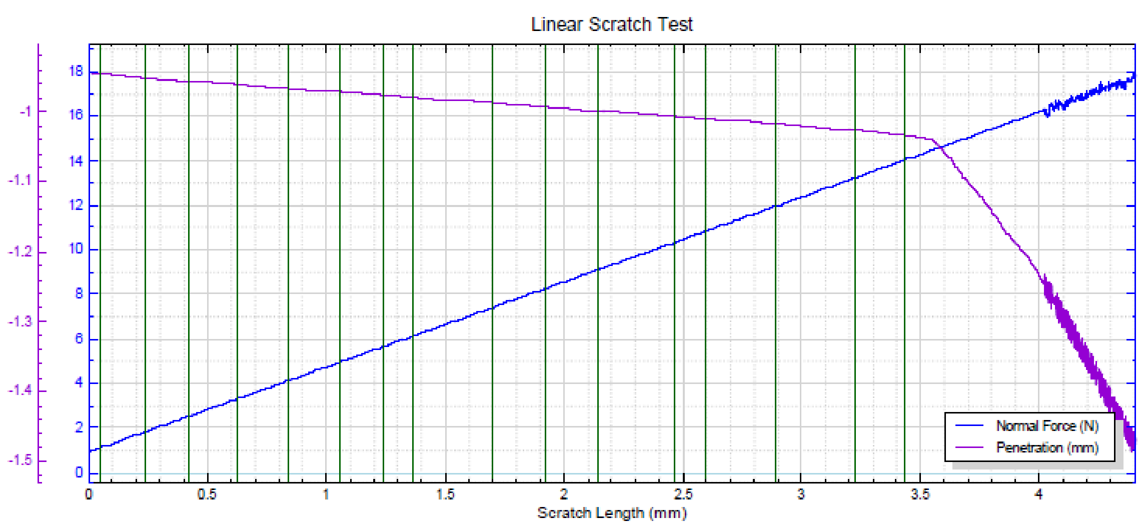


Qualitative EDAX analysis on the surface of the sample section - 316L stainless steel covered by the EB-PVD process with NiCrAlY and Al_2O_3



SEM morphological aspect of the deposition surface by the EB-PVD process - Al_2O_3 on stainless steel substrate





Sample adhesion test - NiCrAlY bonding layer and Al_2O_3 layer deposited by the EB-PVD process on 316L stainless steel substrate are scratched with NANOVEA " - identor

CONCLUSIONS

Due to their excellent properties, high corrosion resistance, high thermal conductivity, Ni-Cr-based alloys have their industrial use. In our research we studied the NiCrAlY and Al_2O_3 materials system deposited on austenitic 316L stainless steel where the electron beam evaporation technique was used. These layers were analyzed in the laboratory, using modern equipment from a chemical and structural point of view, it the aim of mainly the realization of new coatings used in different applications in the nuclear industry.

References:

[1]. Jun Lim Il, Soon Hwang, Ji Hyun Kim, *Journal of Nuclear Materials* 441 (2013) 650–660.

[2]. Victor Aurel, Andrei Cristiana Radulescu, Viorel Malinovschi, Alexandru Marin, Elisabeta Coaca, Maria Mihalache, Cristian Nicolae Mihailescu, Ioana Daniela Dulama, Sofia Teodorescu and Ioan Alin Bucurica, *Coatings* (2020) 10, 318.

[3]. W.Li, Ding, M.-H.; Zhang, H.-S.; Zhang, B. *J. Alloys Compd*. 7305 (2018)219–227.

Acknowledgement:

This work was carried out with financial support from the Romanian Ministry of Education and Research, through the Project PN 19190401. and the Institute for Nuclear Research Pitesti – ICN.