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Characterization of the oxide layer on Ni based alloy coatings

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Abstract – The oxide layer that forms on coatings strongly influences their behavior under carburizing environments. This study characterized the oxide layer that formed on a Ni based coatings. The influence of Al in a NiCrMo alloy and of the chemical composition of the substrate steel on the development of the oxide was evaluated. α-alumina formed on Al modified coatings which replaced the Cr oxide observed on deposits processed on AISI1020. Processing on stainless steels plates strengthen the Cr oxide layer which developed together with the α-alumina on coatings processed with the Ni alloy modified with Al on AIS304 plates.

Carburizing resistance of Ni based coatings modified with Al has been associated with the development of aluminide phases [1]. In FeCrAl alloys this behavior as been associated with a duplex oxide layer of chromium oxide and alumina which acts as a barrier to the diffusion of C into the material [2]. This work is part of an ongoing project and aimed at characterizing the oxide layer that developed on coatings processed by Plasma Transferred Arc (PTA) with a NiCrMo alloy, with and without 25wt%Al, on AISI1020 and on AISI 304 steel plates. Coatings were exposed to 1100C for an hour in a low PO_2 environment in order to develop α-alumina on coatings containing Al. Raman analysis [3] and scanning electron microscopy were used to characterize the oxide layers.

Under the conditions tested, results confirmed that α-alumina developed on coatings processed with the Ni alloy modified with Al, figure 1, whereas those without Al developed a chromium oxide layer. The latter was continuous on coatings processed on the stainless steel plate, suggesting that the Cr migrated from the substrate steel into the coating and contributed to the development of the oxide. The chromium oxide layer observed with SEM under the secondary electrons mode revealed the solidification structure of the coating.

The oxide layer on coatings processed with the mixture of the atomized NiCrMo alloy with Al presented different features depending on the chemical composition of the substrate steel. On deposits processed on carbon steel the α-alumina layer exhibited regions with different morphologies and no evidences of Cr oxide. Processing on stainless steel plates resulted on coatings with a double oxide layer of alumina plates over a Cr oxide layer, figure 2.

The oxide layer that formed on the processed coatings depended on the chemical composition of the deposited material as well on that of the substrate steel. Elements from the substrate steel were incorporated into the coating during processing and diffuse to the surface.

The presence of Al in the deposited material resulted on the development of α-alumina, which replaced the chromium oxide layer on deposits processed on carbon steel plate and allowed to develop a double oxide layer on coatings processed on stainless steel substrates

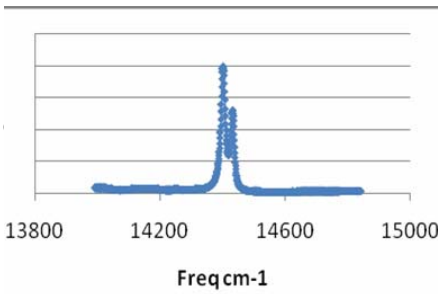

Figure 1 - α alumina identified by Raman analysis

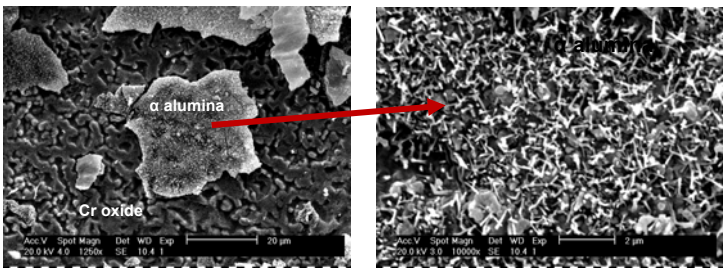

Figure 2 –Oxide layer on the surface of NiCrMo coatings modified with Al b) detail of the alumina

References

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