Room Temperature Mechanical Properties and Tribology of Nicralc and Stellite as Cast Alloys.

Silva, W. S.[1]; Souza, R.M.[2]; Mello, J.D.B[3]; Goldenstein*, H. [1]
[1]Universidade de São Paulo, Escola Politécnica, PMT – wsantana@usp.br.
[2]Universidade de São Paulo, Escola Politécnica, PME.
[3]Universidade Federal de Uberlândia, Faculdade de Engenharia Mecânica.

Abstract - NICRALC is a family of IC based casting alloys proposed as a substitute for abrasion and erosion resistant cobalt alloys. NICRALC microstructures contain hard chromium carbides dispersed in continuous γ'($L1_2$), Ni-Al-Cr ordered intermetallic matrix. As cast NICRALC and Stellite 6 alloys were tested with regard to room temperature mechanical and tribological properties.

NICRALC, a new cast high temperature abrasion and oxidation resistant alloy is compared with STELLITE 6, a cobalt based alloy traditionally used for the same purpose. The motivation is the possibility of obtaining similar performance at a fraction of the cost. The main idea behind the NICRALC family of alloys is to obtain a microstructures with hard carbides dispersed in a continuous γ' (L_{12}) ordered intermetallic matrix. Dispersions of chromium rich eutectic and/or proeutectic carbides similar to the ones obtained in High Chromium White Cast Irons, with a predominantly γ' matrix, were obtained [1].

The aim of this work is to compare the wear resistance of a Ni based alloy (**NICRALC**) and of a Co based alloy (**STELLITE 6**). The alloys are tested as investment-cast material (**Figure 1**). Mechanical properties were evaluated by compression, hardness and fracture toughness [2] measurements; tribological properties were evaluated by cavitation, rubber-wheel wear [3], reciprocating wear [4] and block-on-ring lubricated wear (FALEX) tests. The mechanical resistance and wear resistance tests were performed at room temperature. The wear and fracture mechanisms were studied using SEM imaging of the worn or cracked surfaces.

Results of mechanical and wear tests are show in **Table 1**. It is shown that at room temperature Nicralc alloy is a softer material than Stellite and thus Stellite performance is measurable better than the intermetallic compound Nicralc alloy with regard to tribological behaviour. In Nicralc alloys wear damage is controlled mainly by the matrix resistance. In the reciprocating sliding tests of Nicralc the wear resistance is dependent of the material used as counter body. When the tests were performed against WC-Co counter bodies, the behaviour of both Nicralc and Stellite alloys were similar but when the counter body used was AISI 52100 Steel, Nicralc alloy displayed a much worst behaviour than Stellite. This behaviour sugests that a tribochemical effect is acting, driven by the high enthalpy of formation of iron aluminide phases. This effect it is still under investigation, using SEM and XRD of the collected debris.

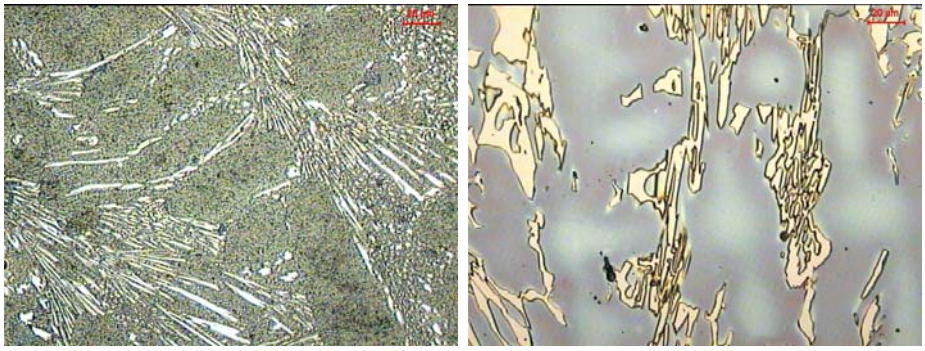

Fig. 1 – Optical images of alloys microstructures, showing the chromium carbides morphologies and matrix. Left side: Nicralc alloy; right side: Stellite alloy.

Table 1 – Mechanical Properties and Wear* of Nicralc and Stellite Alloys.

Alloy	E [GPa]	$HV_{1.0}$ [MPa]	YS [MPa]	K_{ICV} [MPa. $m^{0.5}$]	Wear [mm^3] [A]	Wear [mm^3]** [B]	Wear [mm^3] [C]
NICRALC	215	400 +/-15	640	54.2+/- 4.0	53.3	0.258	110,0
STELLITE	280	450 +/-13	930	41.2 +/- 1.1	25.9	0.247	7,0

[A] Lost Volume by Abrasive Wear Test; [B] Lost Volume by Reciprocating Sliding Test (WC-Co counter body); [C] Lost Volume by FALEX Test.
* Cavitation mass loss was not detected in both alloys after preliminary tests.

References

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