11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Mechanical and tribological properties of a DLC-coated aluminium-silicon alloy

M.P.A.S. Santos*(1), M.M. Maru(2), J.C. Damasceno(2) and S.S. Camargo Jr.(1).

(1) Metallurgy and Materials Engineering, Federal University of Rio de Janeiro. P.O.Box 68505, 21945-970, Rio de Janeiro, RJ, Brazil.
(2) Materials Metrology Division, INMETRO, Av. N. Sra. das Graças, 50, 25250-020, Duque de Caxias, RJ, Brazil.
* Corresponding author. E-mail: mpolo123@metalmat.ufrj.br .

Abstract - In this work, mechanical and tribological properties of DLC-coated aluminum-silicon 319.0 alloy were studied. Results show that DLC coatings are well adhered, increasing hardness from 1 GPa to up to 16-17 GPa, while friction coefficient is reduced from about 0.65 to below 0.2. The wear rate of these alloys was reduced by three orders of magnitude from 10^{-4} to 10^{-7} $mm^3N^{-1}m^{-1}$.

In the automobile industry, aluminum-silicon alloys can replace steel in many applications, such as manufacture of engine blocks, pistons and gears. However, friction and wear can be the limiting factors for the useful life of such automobile parts. Diamond-Like carbon (DLC) coatings have been successfully employed in several tribological applications providing low friction coefficients and wear rates even in the absence of liquid lubricants [1].

In this work, mechanical and tribological behavior of DLC-coated aluminum-silicon 319.0 alloy was investigated. DLC films were deposited onto the substrates by plasma enhanced chemical vapor deposition (PECVD) from pure methane. Film thickness ranged about 2 – 3 µm. Samples were polished, cleaned and submitted to argon plasma cleaning before deposition. A thin amorphous silicon layer was deposited in order to obtain good adhesion. Some of the samples were also submitted to a nitrogen plasma treatment before starting the deposition. Hardness of the samples was measured by nanoindentation with applied loads of up to 50 mN. The tribological properties were investigated using a reciprocating test under 5 N load and 0.1 m/s speed.

DLC coatings improve tremendously the mechanical and tribological properties of aluminum-silicon alloy. Hardness was increased from about 1 GPa to 16-17 GPa (figure 1). Friction coefficient of coated samples was reduced from 0.6 to 0.2, while wear rate was approximately $10^{-7}mm^3N^{-1}m^{-1}$, which is three orders of magnitude smaller than the samples without coating (figure 2). Improvement of the tribological properties is related to the formation of a graphitic tribolayer and a reduction of plasticity of the substrate due the DLC coating [1,2].

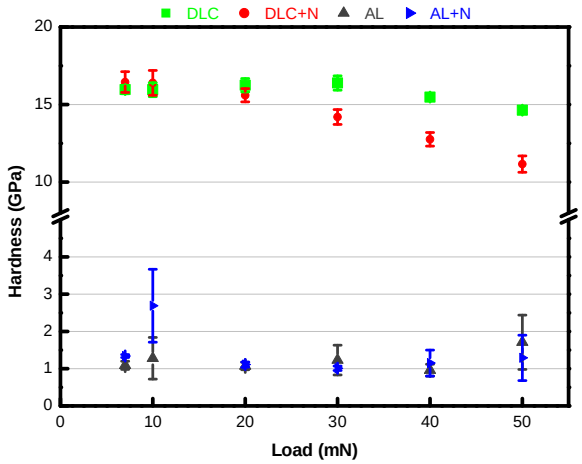

Figure 1: Hardness values obtained by nanoindentation. AL-pure substrate. DLC-substrate with DLC film. AL+N-nitrided substrate. DLC+N-nitrided substrate with DLC film.

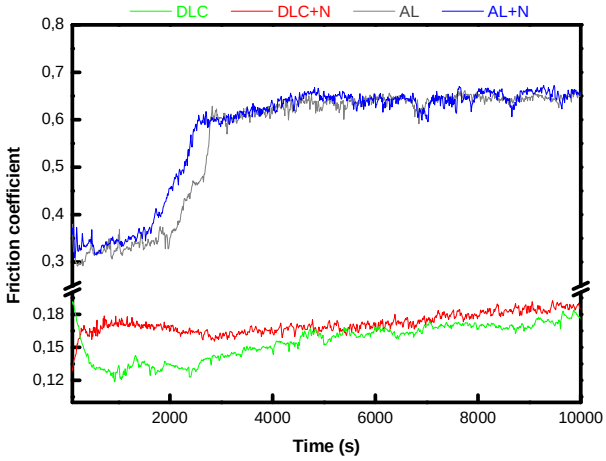

Figure 2: Friction coefficient during reciprocating test. AL-pure substrate. DLC-substrate with DLC film. AL+N-nitrided substrate. DLC+N-nitrided substrate with DLC film.

References:

[1] GANGOPADHYAY, A.K., WILLERMET, P.A., TAMOR, M.A., VASSELL, W.C., "Amorphous hydrogenated carbon films for tribological applications II. Films deposited on aluminium alloys and steel", *Tribology International*, v. 30(1), pp. 19-31, 1997.
[2] LIU, Y., MELETIS, E.I., "Evidence of graphitization of diamond-like carbon films during sliding wear", *Journal of Materials Science*, v. 32, pp. 3491-3495, 1997.