Tribocorrosion and corrosion resistance in Artificial Saliva of TiN/nc-TiN/a-Si_3N_4 coating deposited by magnetron sputtering.

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Statement of Purpose:
In this work a nanocomposite coating layer of nc-TiN/a-Si3N4, a promising nitride coatings to extend the life time of mechanical components due to its high hardness value (>40 GPa), were deposited on metallic substrates by a DC and RF reactive magnetron sputtering technique from Titanium and Silicon targets respectively, using interface layers of TiN and Ti and its performance evaluated under corrosion and combined wear and corrosion conditions. Understanding how coatings perform under these conditions is essential if the service life of products in contact with Artificial saliva is to be predicted and to allow service life to be extended. Therefore, the performance of this TiN/nc-TiN/a-Si_3N_4 coating deposited by Reactive magnetron sputtering is discussed and the main mechanisms associated with their degradation under combined wear and corrosion highlighted. Coating composition, microstructure, adhesion, cohesion and substrate properties are seen as some of the critical elements during this study.

Title
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Methods:
TiN/nc-TiN/a-Si3N4 coating were prepared by reactive unbalanced magnetron sputtering from two different targets (Ti and Si).
Crystallite size was measured using XRD

Results:
The XRD data of the coating coatings exhibited a broad reflection (111 and 200) of cubic TiN phases. XPS showed a range of Si content between 3.4% and 17.4%.
The nanocomposite coating exhibited a hardness range between 35 and 45 Gpa. Testing was performed on the Area with higher hardness (nearest to the Ti target while deposition) and with an average value for hardness of HV=41.13GPa and Si% above 5%. The Crystallite size for ths TiN was below the 10nm.
Corrosion and tribocorrosion testing was performed and some of the relevant data is being included below.

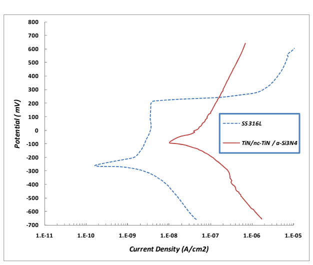

Fig.1. Potentiodynamic polarization curves in Artificial Saliva.

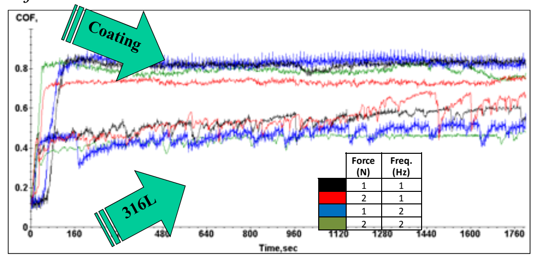

Fig.2. Comparison between TiN/nc-TiN/a-Si_3N_4 against 316L in terms of COF for different testing conditions on Artificial Saliva.

a. b.

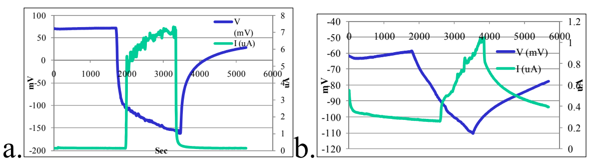

Fig. 3. Comparison between 1N/1Hz condition a)SS316L and b) Coating. Note the higher current for the substrate*
*Please note that only one out of the four conditions is being showed here (but performance is similar on the other three)

Conclusions:
The coatings showed the desired data after synthesis: High hardness value (above 35GPa), Silicon content between 3.4% and 17.4% and TiN crystallite size below 10nm. The corrosion performance of the coating showed a better performance compared with the substrate until failed (around 200mV) . The tribocorrosion behaviour of TiN/nc-TiN/a-Si3N4 coating sliding against alumina in Artificial Saliva was investigated in a ball-on-flat contact configuration combined with in situ electrochemical noise measurements. The effect of applied normal force, and sliding velocity on corrosion–wear of the tested materials were determined. An increase in the normal force and the sliding velocity induce an increase in current and a decrease in potential accelerating the de-passivation of the coating and substrate. The fluctuations in current and voltage (potential) during fretting become larger at increasing sliding frequency than at increasing normal force. This is more obvious for the substrate than for the coating. During fretting-corrosion, sliding promotes the dissolution of stainless steel and coating (respectively on their tests) due to the removal of the surface film and the exposure of active material to the artificial saliva. This dissolution process is revealed by a anodic current (Higher on the substrate). Also a subsequent repassivation of active material takes place during fretting-corrosion creating a material surface dynamic evolution in the wear track.

References: S. Veprek, The search for superhard materials, J. Vac. Sci. Technol. A 17 (1999) 2401–2420.