NANOTECHNOLOGIES

UTAustin Portugal

Influence of Ag content on the high temperature tribological behavior of TiSiN(Ag) films deposited by HiPIMS

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Background

TiSiN coatings alloyed with increasing silver content were deposited for designing a self-lubricant coating with controlled lubricant element diffusion. This system was already characterized in terms of its mechanical and structural properties. The coatings were also submitted to annealing in protective and non-protective atmospheres. Results suggest that silver diffusion control was achieved.

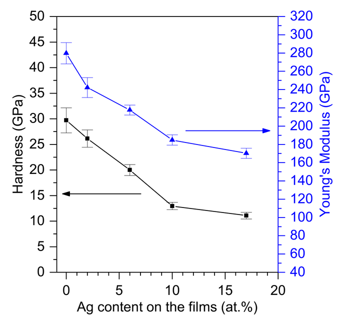

Figure 1. Hardness of the TiSiN(Ag) coatings

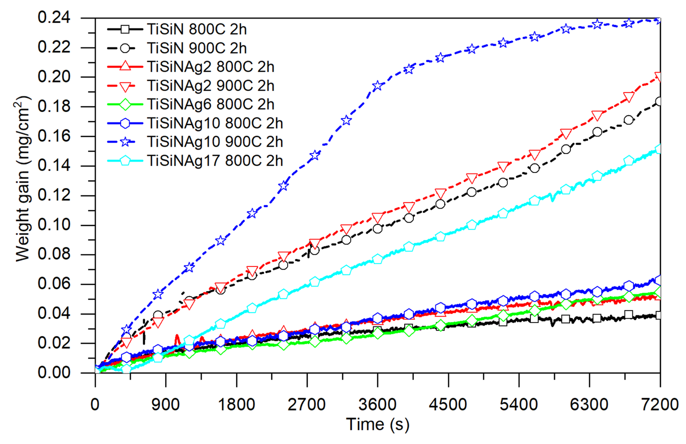

Figure 2. Isothermal curves for the TiSiN(Ag) coatings performed at 800ºC and 900ºC for 2 hours

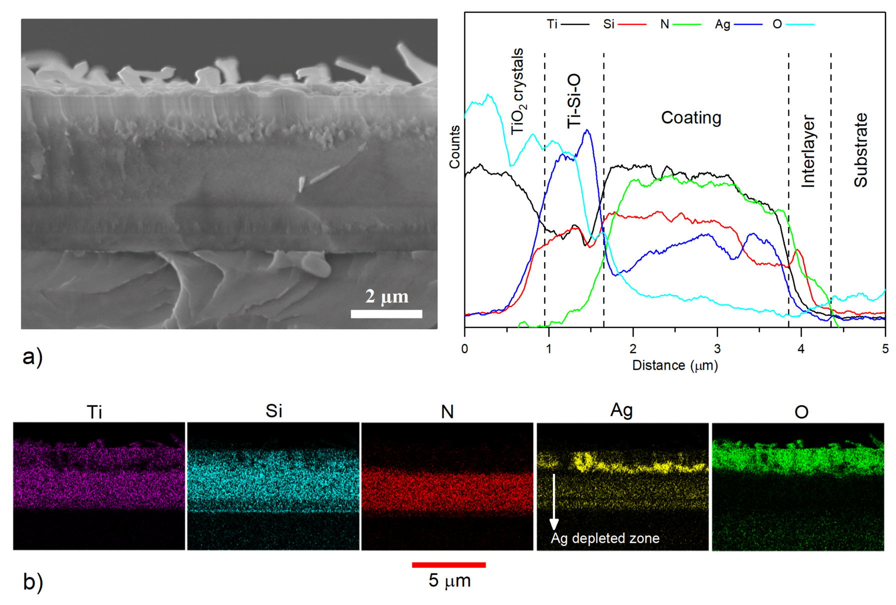

Figure 3. Line profiles and elemental maps of the distribution of the elements on the TiSiNAg6 coating submitted to 800ºC for 2 hours

Methodology

The films were deposited in reactive mode using an HiPIMS power supply. The Ti target (99.9% purity) was machined with holes where Si and Ag pellets were introduced to control the chemical composition of the films. An interlayer and gradient layer were deposited for adhesion purposes. Substrates used for tribology were WC discs (Ø 20 mm). The tests were conducted at RT and at 600ºC in a pin-on-disc device. The counterparts used were alumina balls.

Figure 4. Target configuration schematic
Chemical composition was controlled by introducing Si and Ag pellets on the holes

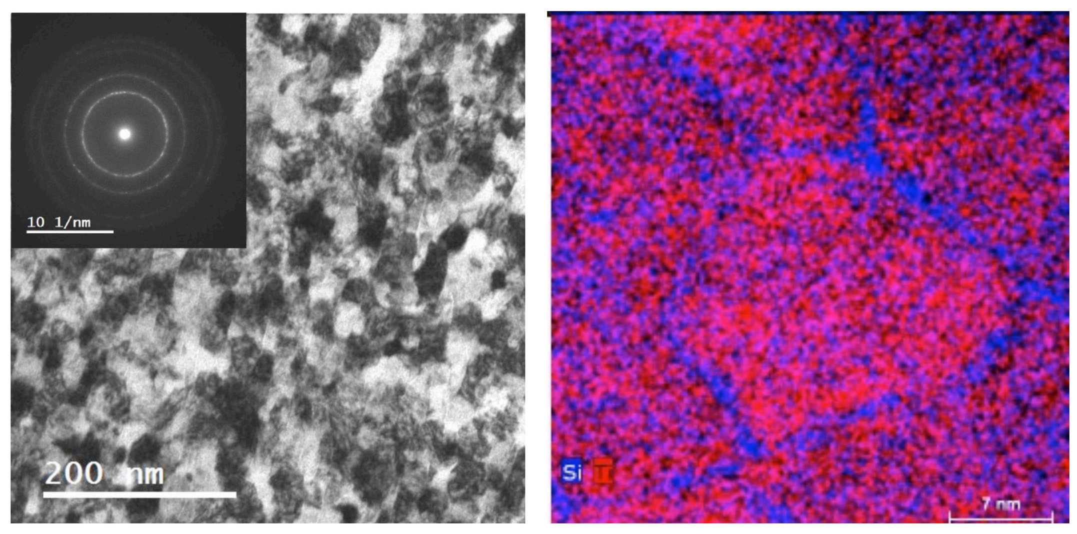

Figure 5. Structure of the TiSiN reference film

Results

Silver content seems to have no impact on the COF at room temperature. However, when the temperature increases to 600ºC, a small decrease in the COF is observed for the increasing Ag content. Despite wear rate increasing with the silver content, increasing the temperature does seem to show an overall decrease in the specific wear rate.

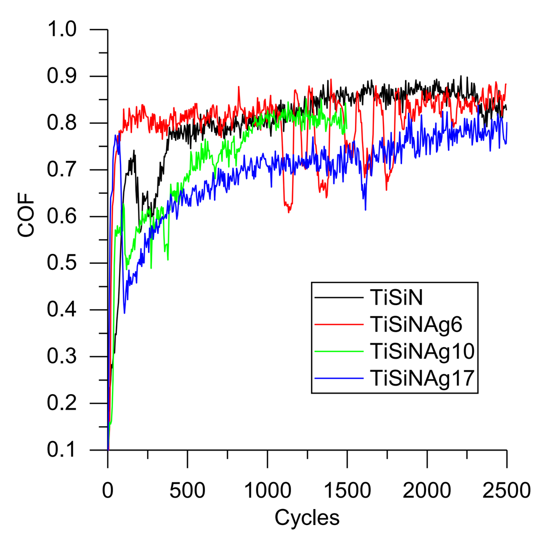

Figure 6. Coefficient of friction of the films tested at room temperature

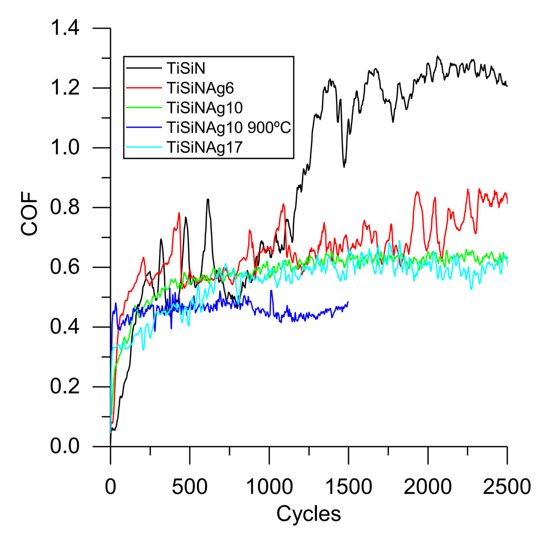

Figure 7. Coefficient of friction of the films tested at 600ºC

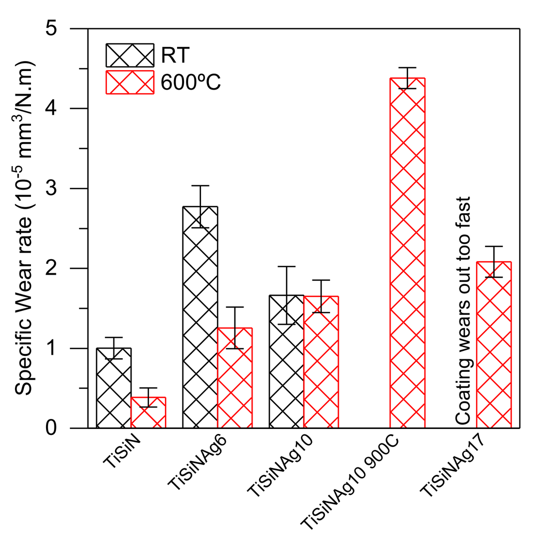

Figure 8. Specific wear rate of the coatings

Impact/Conclusions

- Hardness and Young's modulus of the coatings decreased with Ag increase as a combined effect of the decrease of the level of residual stresses and due to the increase of the soft phase.
- Silver content shows no influence on the onset point of oxidation of the coatings.
- Despite the oxidation of the coatings, silver continues to be homogeneously distributed on the un-oxidized part of the film.
- Silver content shows no effect on the COF at RT.
- Small decrease of the COF when the temperature is increased to 600ºC.
- An overall decrease of the specific wear rate is also observed when the temperature increases to 600ºC.

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