

Wear resistant coatings on aluminum

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Introduction

This work is part of the IOP-OT project. It includes industries, like Corus, universities, Eindhoven and Delft and research centers, like TNO-TPD and TNO-industry.

Objectives

There is a growing interest in wear resistant layers on Al for use under light sliding loads. The wear resistant layers we want to achieve are either Diamond Like Carbon (DLC) or metal-carbonitrides. In this recently started project we have as objectives to formulate criteria for such layers to be successful and to obtain these criteria using any of a number of deposition techniques. These techniques include:

- Unbalanced magnetron sputtering PVD, in house.
- PECVD, TNO.
- expanding arc plasma PVD, Applied physics dept.

Initial approach

The initial approach is purely experimental, aimed at quick assessment of the main problems that occur. Two main problems have to be tackled:

- Unfavourable mechanical properties of Al (low hardness). This is of course related to the need for a coating. Question is, how thick and hard does a coating have to be to sustain concentrated mesoscopic loads in typical contact situations.
- Unfavourable thermal properties of Al (low melting point(T_m), high coefficient of thermal expansion). This is a problem related to the deposition of the layers that usually takes place at elevated temperatures, say $0.6 T_m$.

Results and Discussion

Films deposited by Plasma enhanced means show a high stress level. As a result the adhesion is quite poor. In order to decrease this stress level, interlayers with a gradient in composition are first applied to the substrate.

References:

- [1] STEPHEN ONRAET: stephen@wfw.wtb.tue.nl
- [2] STAN VEPREK: *The search for novel, superhard materials* (J.Vac.Sci.Technol.A 17(5), Sept/Oct 1999).

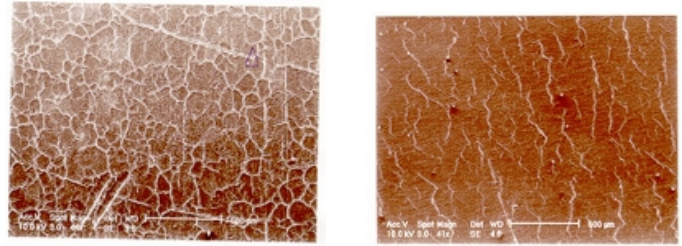


fig. 1 Left:AITiTiN sharp interface - Right: AITiTiN gradient interface

DLC-Ti coatings deposited on Al with interlayers, show column-like growth on top of a rippled substrate. Etching phenomena dominate the deposition process: structure and composition.

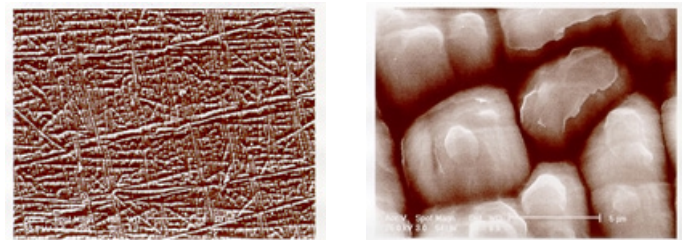


fig. 2 Al...TiC-H Left: bar=20 μ m Right: bar=5 μ m

To prevent the etching of Al, NiP coated substrates are used. The resulting structure is more homogeneous with no "etched like" pattern and with less cracks.

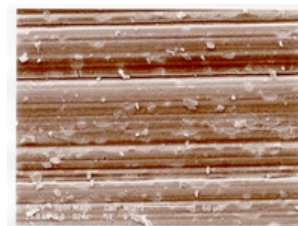


fig. 3 AlNiP...TiC-H: bar=50 μ m

Conclusions

- Gradient in composition plays a dominant role in internal stress.
- Etching is important, mainly because of the high deposition temperature($T_d = 0.6 T_m$).
- As a result, the deposition temperature has to be decreased
- Further investigations on the ALNiP system have to be performed (smoother NiP layer, thickness dependence).