Production and characterisation of PVD titaniumcarbide coatings

PRODUCTION AND CHARACTERISATION OF PVD TITANIUMCARBIDE COATINGS

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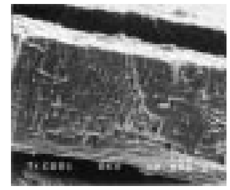


Introduction

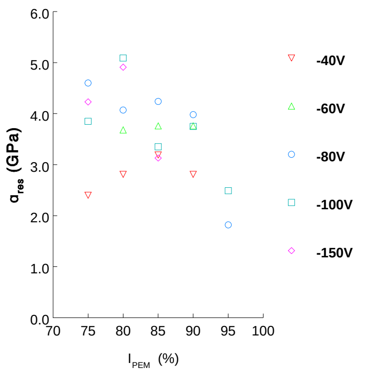
Hard titaniumcarbide coatings can be used for protecting machine tools against abrasion and corrosion and so extending the tools lifetime. In this work it is shown how to measure and change the chemical composition and mechanical properties of titaniumcarbide coatings.

Experimental

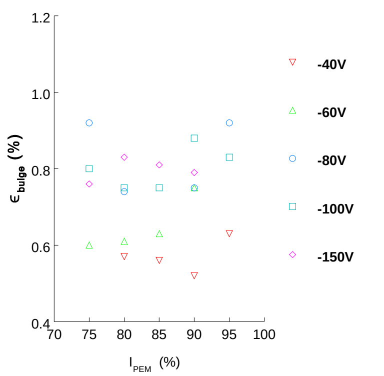
Thin layers of titaniumcarbide are deposited on stainless steel substrates by unbalanced magnetron sputtering. The coatings are made by the reaction of sputtered titanium and acetylene in an argon plasma. The acetylene flow is controlled by using a plasma emission monitor (I_{PEM}).
The chemical composition of the coatings is determined by the enforced gas flow. The mechanical properties of the coatings are determined by the applied bias voltage.
Coatings are chemically examined by XPS, XRD and EPMA. The mechanical properties of the coatings are examined by measuring the residual stresses and by determining coating failure in bulging and bending. The last two in tensile condition.

Results

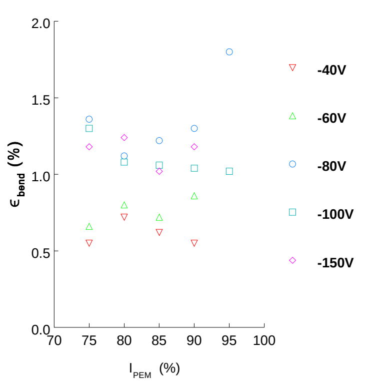
Coatings produced with I_{PEM}=75% show to be stoichiometric. Coatings produced with I_{PEM} >75% also contain an increasing amount of Ti.



Residual stress as a function of the enforced gas flow



Strain to failure for bulging as a function of the enforced gas flow



Strain to failure for bending as a function of the enforced gas flow

I_{PEM}	75%	80%	85%	90%	95%
$at\%Ti$	59	60	71	71	95
$at\%C$	41	40	29	29	5
$\frac{[Ti]}{[C]}$	1.4	1.5	2.5	2.5	19

Discussion

Coatings produced with values of I_{PEM} >75% contain free titanium as well as titaniumcarbide. Taking into acount that titanium is more ductile than titaniumcarbide, this explains the higher strains to failure for higher values of I_{PEM}.
Since the direction of the applied stresses in bending and bulging are opposite to the direction of the residual stress, it is expected that the strain to failure for bulging and bending will increase as the compressive residual stresses in the coating will be higher. The figures affirm this.
It is also evident that bias voltages of -80V, -100V and -150V give almost the same mechanical behaviour.

Conclusions

* The production of stoichiometric titaniumcarbide is possible.
* The mechanical properties can be adjusted for a given application.
* There is no use of applying a more negative bias voltage than -80V when producing titaniumcarbide coatings.