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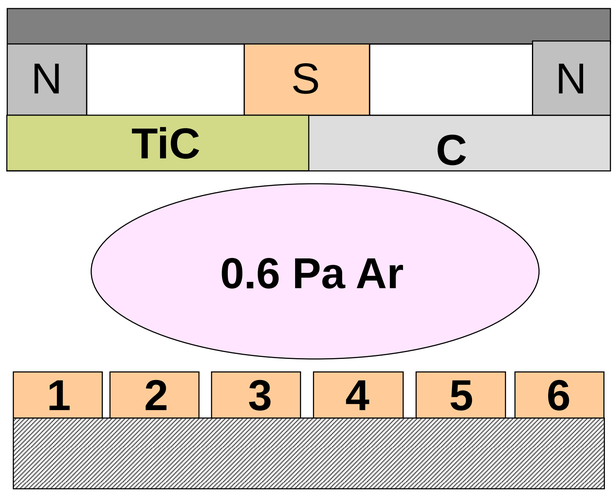
The correlation between the constitution, microstructural evolution and properties of non-reactively magnetron-sputtered TiC/a-C nanocomposite coatings – a review

Preparation and characterisation of TiC/a-C nanocomposite coatings

Nanostructured carbon-based composite coatings
Combinatorial materials science approach (segmented target)
Non-reactively DC magnetron-sputtering process
Correlation of constitution, microstructure and properties
EPMA, XRD, TEM, HRTEM, AFM, XPS, Raman spectroscopy
Vickers hardness & Young`s modulus (nanoindentation)
Unlubricated sliding wear behaviour (pin-on-disk testing)



P = 500 W DC

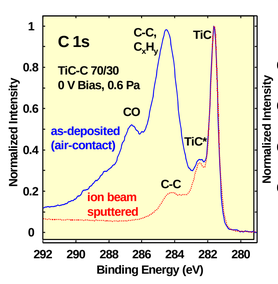
0, 150, 300 V RF-Bias

Constitution, microstructure and properties of TiC/a-C nanocomposite coatings

	Pos. 1	Pos. 3	Pos. 4	Pos. 6
0 V				
at% Ti	32.2	33.4	31.6	23.7
at% C	66.9	65.9	68.0	75.4
Ti:C	0.48	0.51	0.47	0.31
300 V				
at% Ti	31.5	32.7	30.5	23.8
at% C	65.8	64.7	66.8	73.2
Ti:C	0.48	0.51	0.46	0.32

Growth Phenomena in Nanocrystalline Carbide/Amorphous Carbon Composites

Observation of a **third carbon bonding state** in XPS analyses **in TiC/a-C nanocomposite coatings**



Binding energies of C1s lines (after ion beam sputtering)

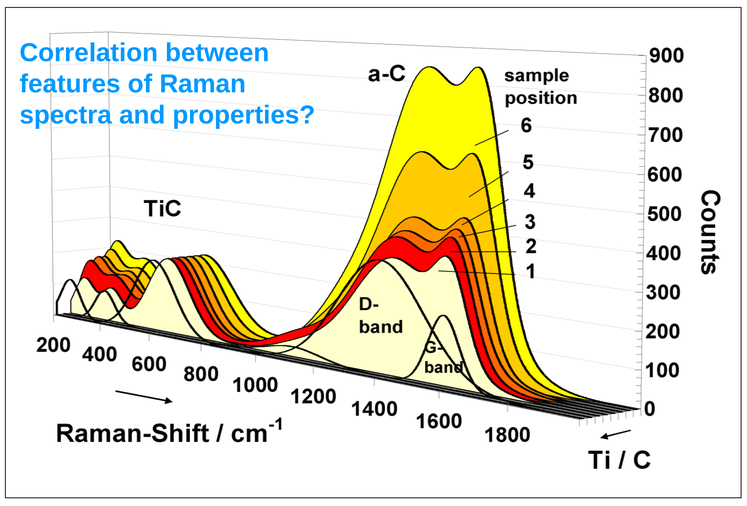
281.6 eV (TiC)
282.4 eV (TiC*)
284.0-284.3 eV (sp^2 C-C)

TiC* = F (C-content, bias,....)

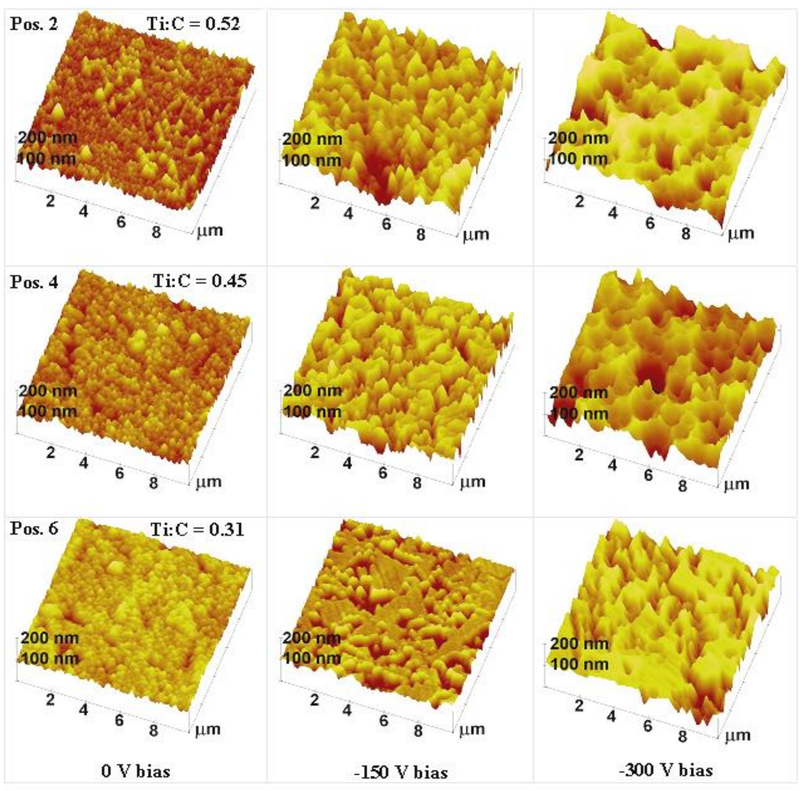
Origin & nature of TiC*? **C in metastable positions of TiC lattice (interstitially modified TiC)?**
Distorted TiC_{1-x} interface phase (separate surface phase on TiC)?
Impact on coating properties?

Joint presentation by E.Lewin, Uppsala University, at E-MRS Warsaw, 3.-8.September.2006

Correlation between features of Raman spectra and properties?

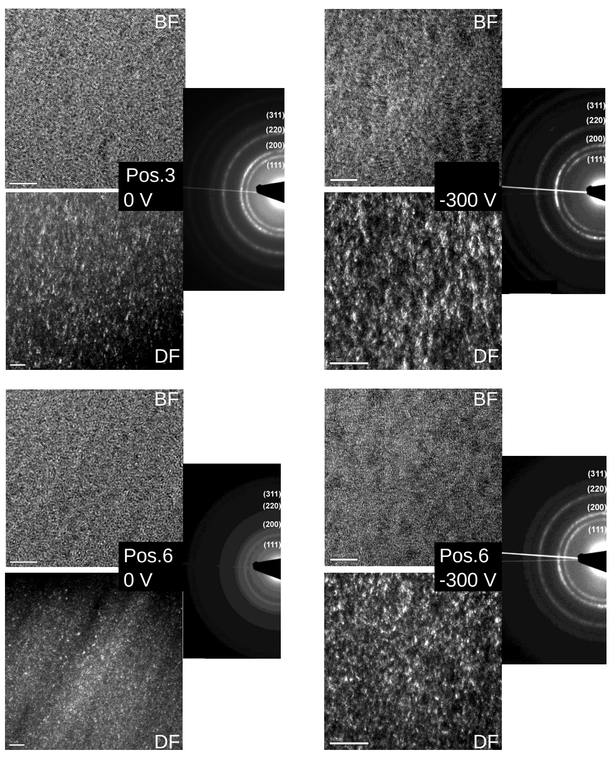


Chemical composition (EPMA)



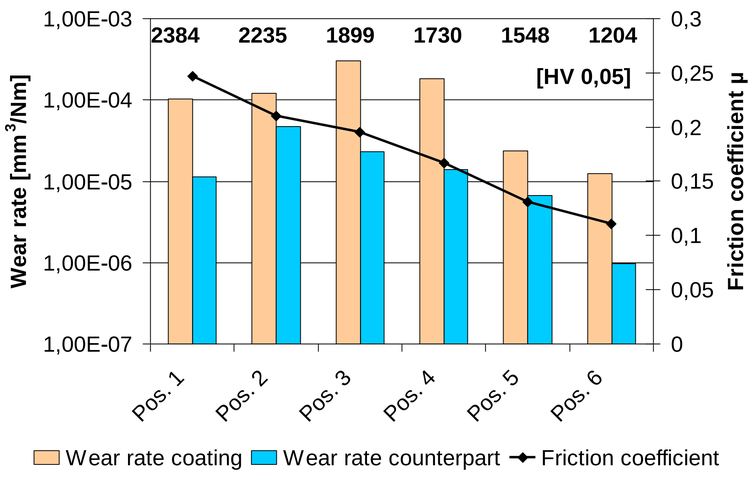
AFM – Surface Topography

X-Ray Photoelectron Spectroscopy

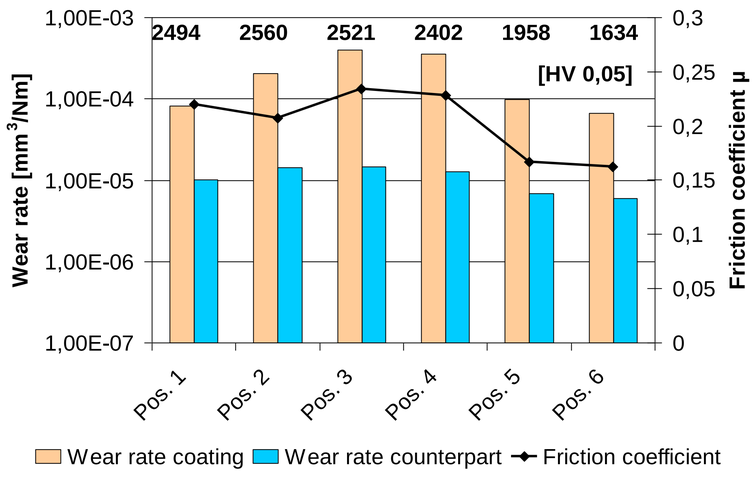


TEM analysis

Raman Spectroscopy (514.5 nm, 3 mW)



Pin-on-disk (100Cr6, 10 N) – 0 V bias



Pin-on-disk (100Cr6, 10 N) – 300 V bias

Conclusions and future research needs

Microstructure, surface topography and properties of nano-structured carbon-based composite coatings determined by:
(I) nanocrystalline TiC phase formation,
(II) amorphous carbon grain boundary or matrix formation,
(III) interaction of TiC and a-C with ions (subplantation vs. re-sputtering)