Technologiezentrum für Oberflächentechnik Rheinbreitbach GmbH

Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft

Symposium B Poster Session

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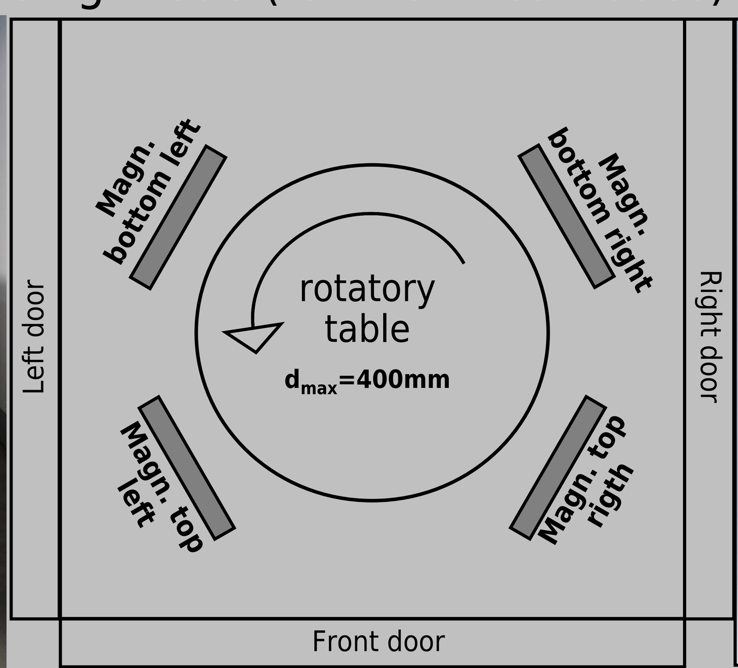
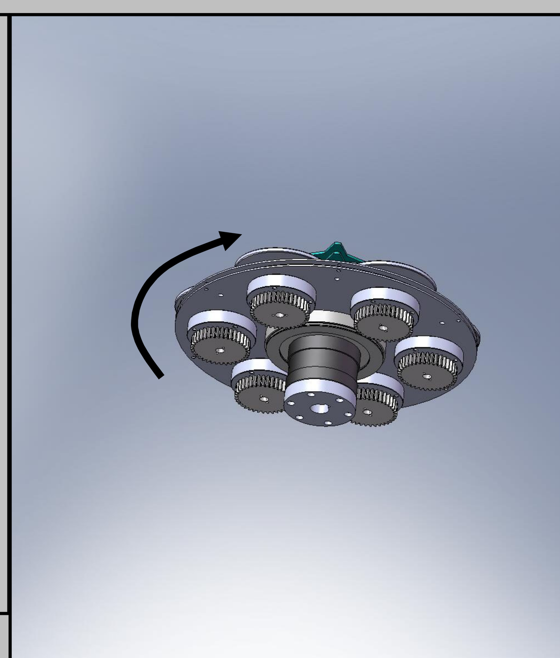
Characterization of Binary, Ternary and Quaternary Hard Coatings in the Material System V-Al-C-N Produced by Industrial Scale Reactive Magnetron Sputter Deposition

Aim of the work: deposition of **new coatings** in the material system **V-Al-C-N** on **industrial** plants, to achieve metastable nanostructured hard layers through systematical variation of deposition parameters as power density, plasma pressure and variation of the partial pressure of process-gases ($Ar:N_2$ and/or CH_4)

Realisation: dc magnetron-sputter industrial deposition system (CemeCon CC800/8) with rf processing mode (for 2 of 4 cathodes)





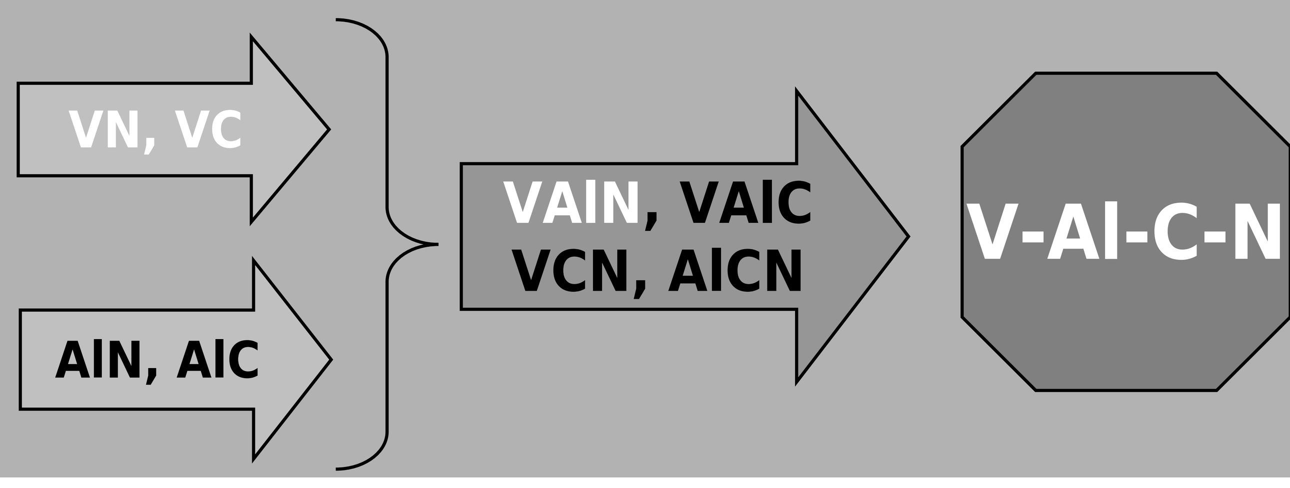
Process steps:

- heating
- etching
- coating
- cooling

Flexible controlling: variation of many parameters in each process step possible

General approach:

- binary coatings: **VN**, **VC**, AlN, (AlC)
- ternary coatings **VAlN**, VCN, VAlC, AlCN
- **V-Al-C-N-coatings**

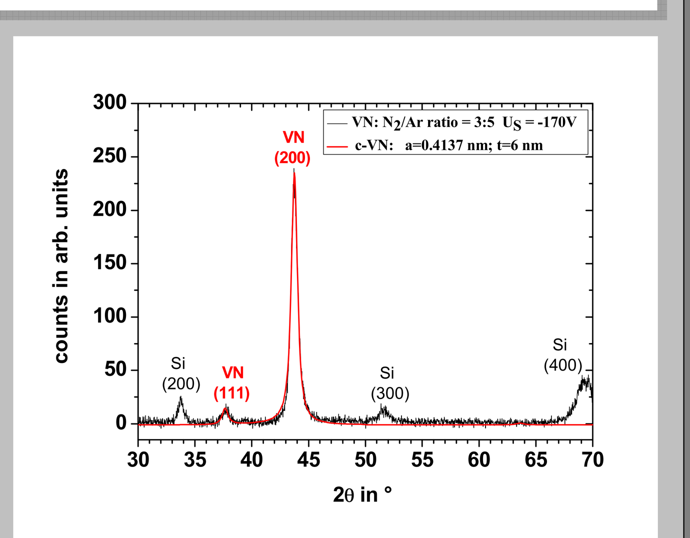


Results in dc-magnetron-sputtered binary VN-, VC-, ternary VAlN- and quaternary VAlCN-coatings:

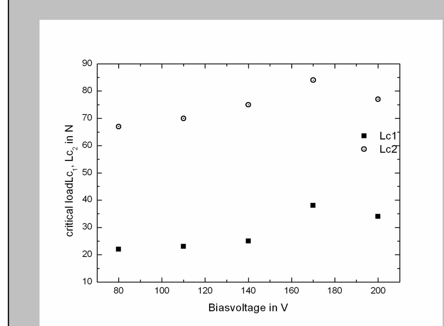
VN-coatings:

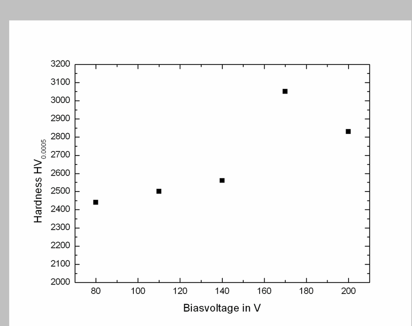
Varied coating parameters $Ar:N_2$ ratio and U_{bias}

$Ar:N_2$-ratio	U_{bias} in V	L_{c1}	HV_{0005}
250/150	-200	34	2830
250/150	-170	38	3050
250/150	-140	25	2560
250/150	-110	23	2500
250/150	-80	22	2440



XRD-spectra: VN crystallite structure of layer with best mechanical properties





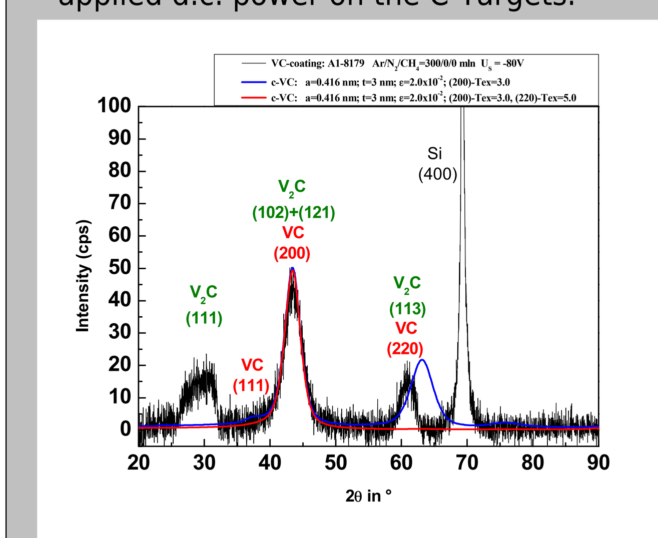
Dependence from critical load and hardness values on bias voltage

VN crystallite size	N in at%	V in at%
6nm	43,18	56,36

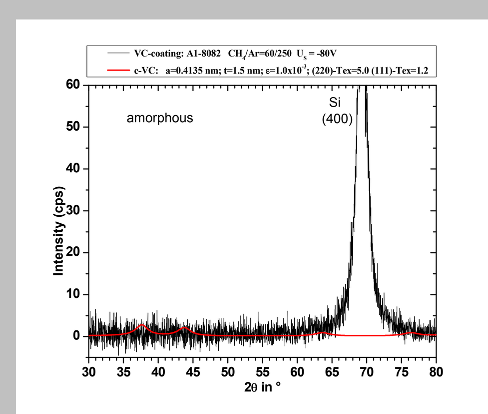
Composition measured by means of EPMA-method

VC-coatings:

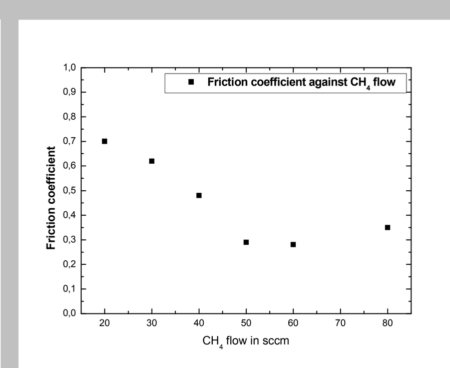
VC-coatings were deposited in two ways: both components V and C from solid state (targets) and reactive: V from solid state and C from CH_4-gas. Varied coating parameters are $Ar:CH_4$ flow-ratio and applied d.c. power on the C-Targets.



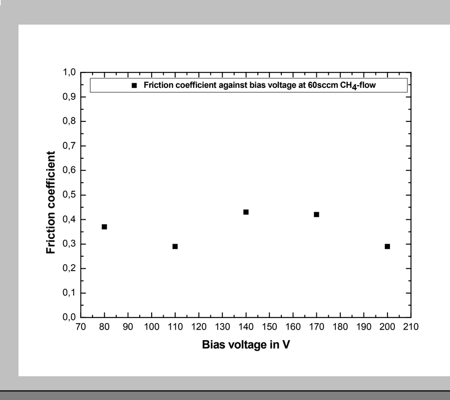
XRD-spectra of an V_2C-layer, deposited by d.c. sputtering from V- and C- targets respectively



XRD-spectra of an amorphous VC-layer, deposited by reactive sputtering from V-Target and Ar-CH_4 gas mixture



Friction coefficient against CH_4 gas flow



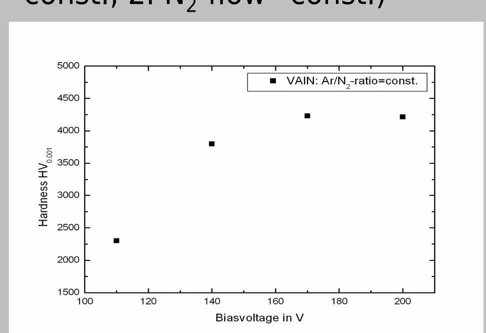
Friction coefficient against bias voltage at constant CH_4 gas flow

VAlN-coatings

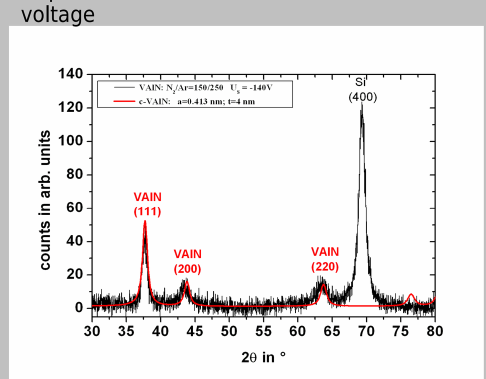
Varied coating parameters are bias voltage, pressure ($Ar:N_2$ ratio, 1. Ar-flow=const., 2. N_2-flow=const.)

U_{bias} in V at $Ar:N_2$=250/150
-80
-110
-140
-170
-200

$Ar:N_2$-ratio 1.case	$Ar:N_2$-ratio 2.case
250/30	300/150
250/50	250/150
250/75	200/150
250/100	150/150
250/150	100/150
250/200	



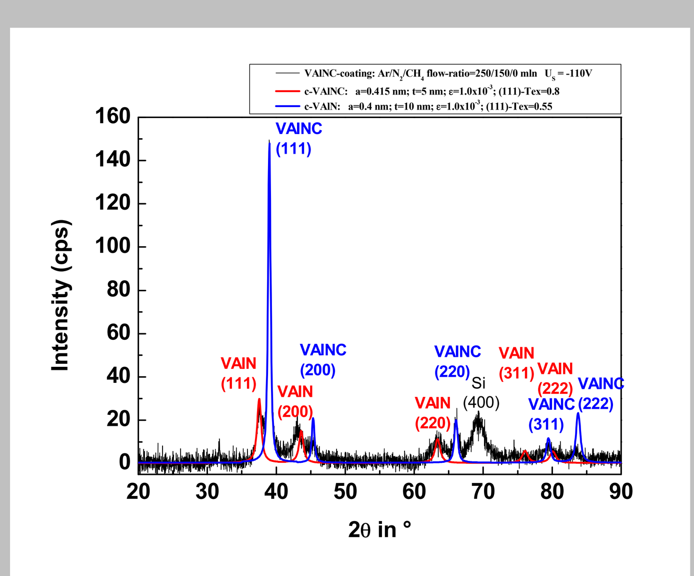
Dependence from hardness values on bias voltage



XRD-spectra: VAlN crystallite structure of layer with best mechanical properties

VAlCN-coatings

VAlCN-coatings were deposited by combining VAlN and C-deposition



XRD-spectra of a VAlN-layer with a VAlCN toplayer

Results and Outlook:

Results VN:

- VN-coating nanocrystalline
- average crystallite size ~6nm
- near-stoichiometric
- friction coefficient ~0.7

Results VC:

- reactively deposited coatings are almost amorphous and show poor mechanical properties
- sputtered coatings (V+C-targets) are nanocrystalline
- average crystallite size ~3nm
- friction coefficient variable through C-content (0.2-0.6)

Results VAlN:

- VAlN-coating nanocrystalline
- average crystallite size ~4nm
- near-stoichiometric
- friction coefficient ~0.7
- mechanical properties advantageous

Results V-Al-C-N:

- C-content in VAlCN-layers has an impact on friction coefficient, see talk E3-2-7 on May, 1st by Dr. Ziebert
- combination of hard, metastable materials with a low friction coefficient on an industrial machine manageable
- first steps to understand the quaternary V-Al-C-N- layer-system through proceeding binary VN-, VC-, ternary VAlN- and quaternary VAlCN-systems are done
- next steps: optimizing the VN-, VAlN- and VAlCN layer-systems

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

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