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IMAUF

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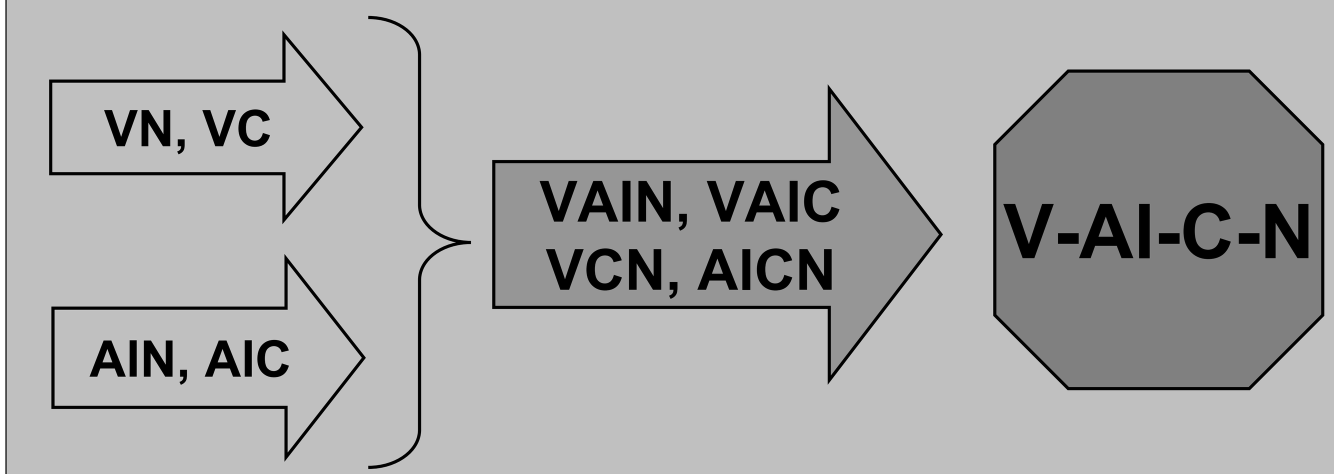
Deposition and characterization of hard coatings in the material system V-Al-N by reactive magnetron-sputtering

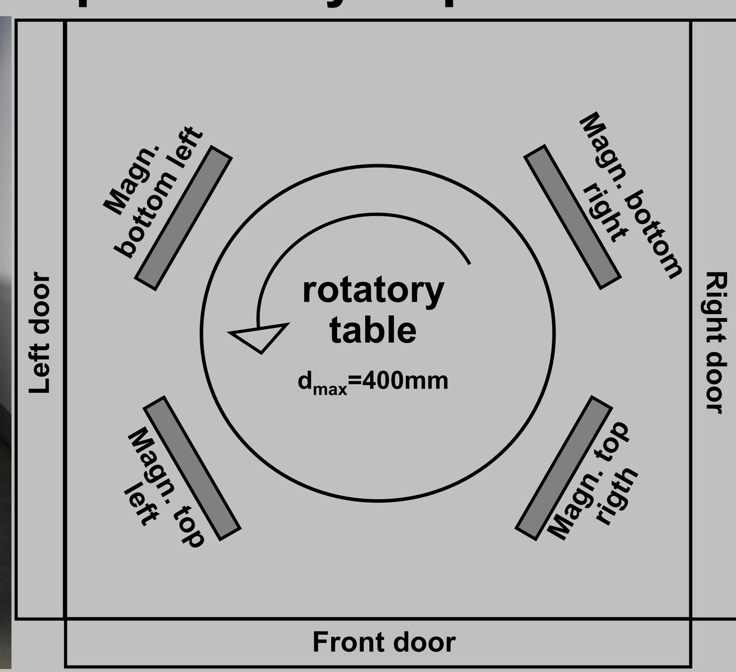
Aim of the work: deposition of **new coatings** in the material system **V-Al-N** on **industrial** plants, to achieve metastable nanostructured hard layers through systematical variation of deposition parameters as power density, plasma pressure and variation of the partial pressure of process-gases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

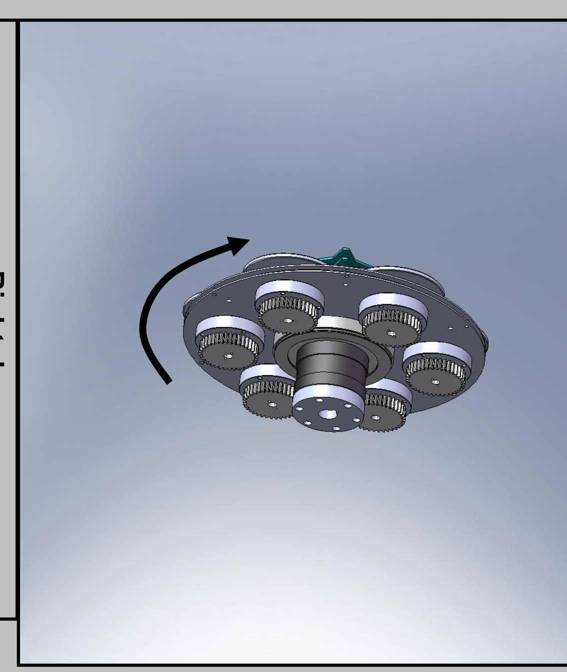
General approach:

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



Realisation: dc magnetron-sputter industrial deposition system (CemeCon CC800/8) with possibility to process in rf mode





Process steps:

- heating
- etching
- coating
- cooling

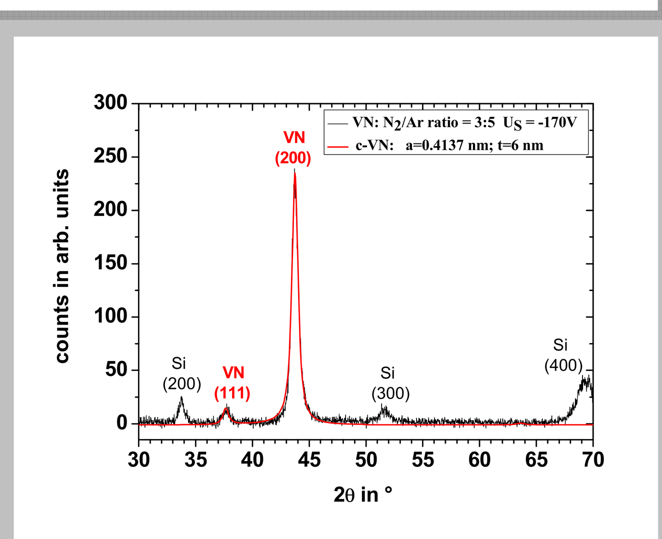
Flexible controlling: variation of many parameters in each process step possible

First results in dc-magnetron-sputtered binary VN-, AlN- and VAlN-coatings:

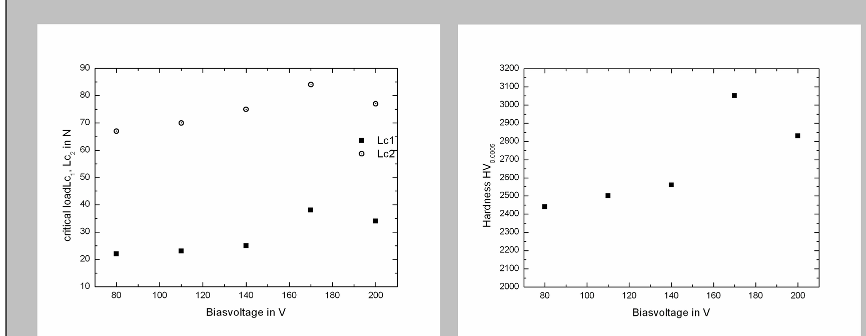
VN-coatings:

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

Ar:N_2-ratio	U_{bias} in V	L_{c1}	$HV_{0.005}$
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: nanocrystalline structure of layer with best mechanical properties



Dependence of critical load and hardness values on bias voltage

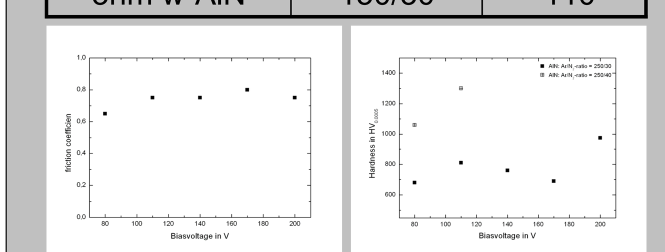
nc-VN	N in at%	V in at%
6nm	43,18	56,36

Composition measured by means of EPMA-method

AlN-coatings:

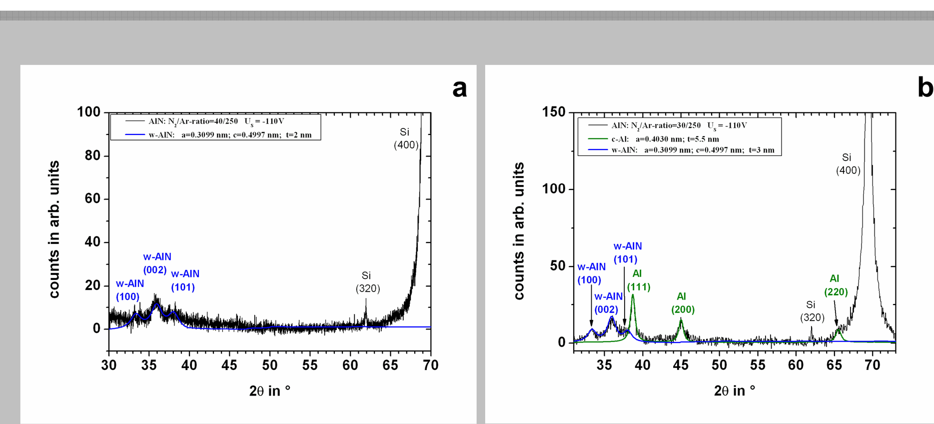
Coating parameters (bias voltage variation)

AlN (or Al+N)	Ar:N_2-ratio	U_{bias} in V
2nm w-AlN	250/40	-110
3nm w-AlN+Al	250/30	-110
3nm w-AlN+Al	250/30	-200
3nm w-AlN	150/30	-110

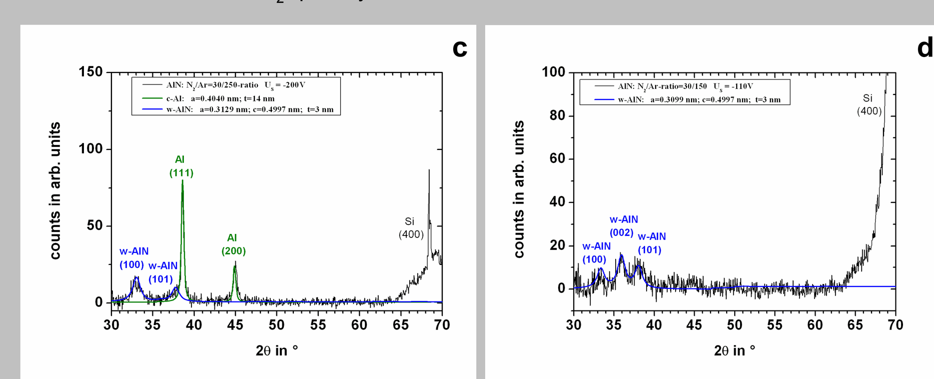


AlN (or Al+N)	N in at%	Al in at%
2nm	38,07	60,68
3nm	30,08	68,78
3nm	43,54	55,37
3nm	17,07	75,22

Composition measured by means of EPMA-method



XRD-spectra of AlN-layers: a.) quasi-crystalline w-AlN structure; b.) w-AlN embedded in Al-matrix due to the lower N_2-quantity

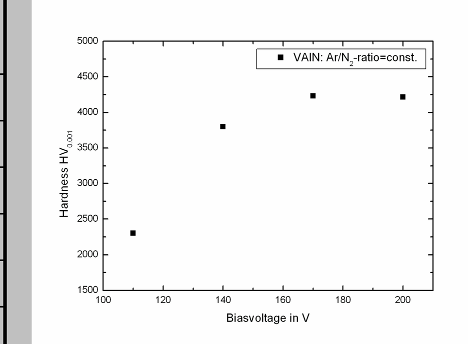


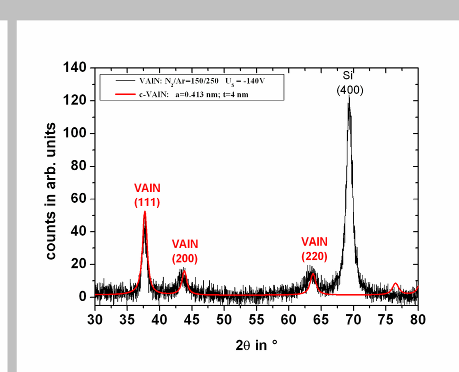
XRD-spectra of AlN-layers: c.) w-AlN embedded in Al-matrix; d.) w-AlN structure

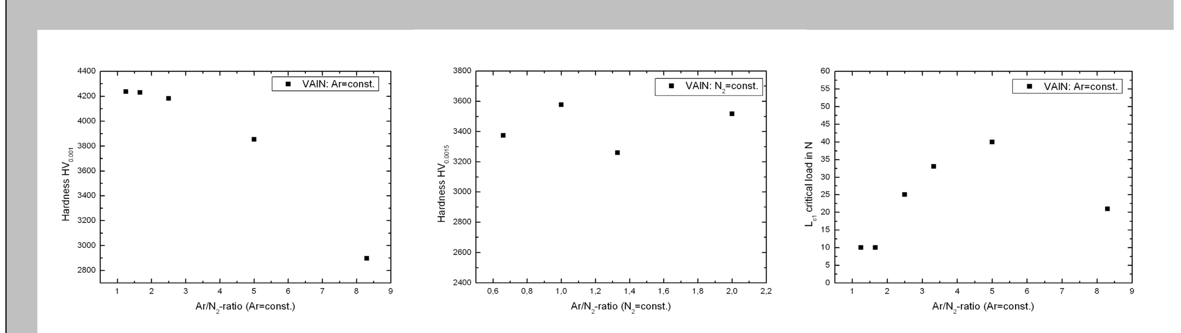
VAlN-coatings:

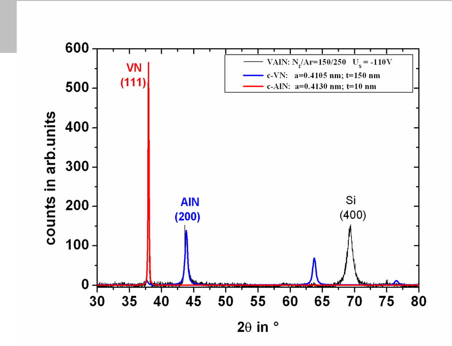
Varied coating parameters are pressure (Ar:N_2 ratio, 1.case Ar quantity=const., 2.case N_2=const.) and U_{bias}

Ar:N_2-ratio 1.case	Ar:N_2-ratio 2.case	U_{bias} in V at Ar:N_2=250/150
250/30	300/150	-80
250/50	250/150	-110
250/75	200/150	-140
250/100	150/150	-170
250/150	100/150	-200
250/200		









Results and Outlook:

Results VN:

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

Results AlN:

- difficult processing by both dc and rf magnetron sputtering
- average crystallite size ~3nm
- w-AlN-structure, near-amorph
- friction coefficient ~0.7
- variation of Ar:N_2-ratio has no influence on friction coefficient

Results VAlN:

- VAlN-coating nanocrystalline
- average crystallite size ~4nm
- near-stoichiometric
- friction coefficient ~0.7
- probably mixture of VN and AlN
- mechanical properties advantageous

First experiments in the material system V-Al-C-N show:

- C-content in V-layers has an impact on friction coefficient (adjustable from 0.2-0.5)
- combination of hard, metastable materials with a low friction coefficient on an industrial machine feasable
- first steps to understand the quaternary V-Al-C-N system by studying binary VN-, AlN-, VC- and ternary VAlN-systems are done
- next steps: fabrication of VC-, VAlC- and AlCN-layer-systems

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