Surface characteristics and wettability of magnetron-sputtered oxygen containing amorphous carbon (a-C:O) thin films

M.Stüber[1], F.Danneil[1], M.Rinke[1], S.Ulrich[1], A.Welle[2], E.Lewin[3], U.Jansson[4]

[1] Karlsruhe Institute of Technology (KIT), Institute for Applied Materials (IAM), D-76021 Karlsruhe (Germany)

[2] Karlsruhe Institute of Technology (KIT), Institute for Biological Interfaces (IBG-1), D-76021 Karlsruhe (Germany)

[3] EMPA Swiss Federal Laboratories for Materials Testing and Research, CH-8600 Dübendorf (Switzerland)

[4] Department of Materials Chemistry, Uppsala University, SE-75121 Uppsala (Sweden)

Motivation & Approach

Amorphous carbon coatings are of interest for bio-functional, biological or engineering applications. Their wetting behaviour can be influenced by plasma-chemical in-situ modification during deposition in H_2, N_2, O_2 and Si-containing atmospheres. We report on **novel oxygen containing amorphous carbon (a-C:O) coatings.** The O-content of the coatings was systematically varied by utilizing different values of the O_2 gas flow.

Characterization of the a-C:O coatings:

Constitution and bonding structure by SEM, XPS, and Raman spectroscopy (at two wavelengths, λ=514.5 nm and 325 nm).

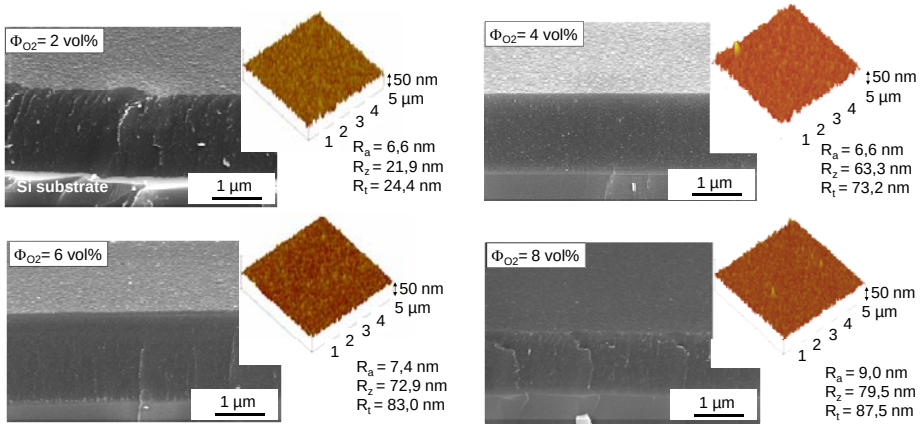
Indentation hardness, Young´s modulus and residual stress

Surface topography analysis by AFM

Wettability: contact angle measurements with different test liquids; calculation of the surface free energy.

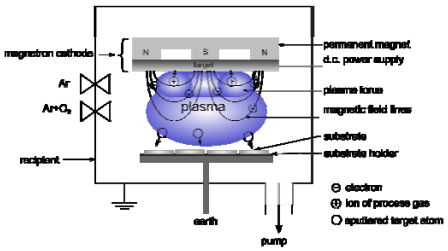
The **correlation of the properties** measured, especially of the wettability and surface free energy, **with the constitution and bonding structure of the coatings** is discussed. A significant influence of the O_2 gas flow on these properties is presented.

SEM and AFM analysis



a-C:O deposition

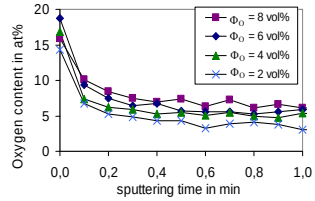
reactive d.c. magnetron sputtering of graphite in Ar/O_2 plasma

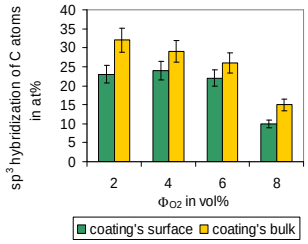


d.c. power: 500 W — substrate temperature < 150°C

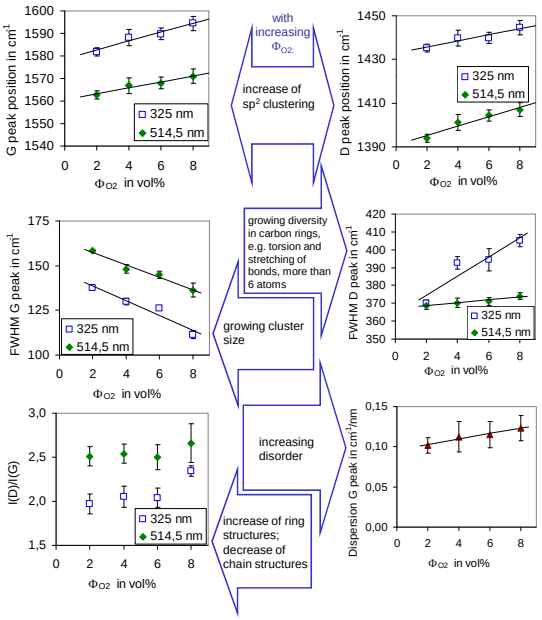
total pressure: 0.6 Pa — O_2 gas flow Φ_{O2} = 2, 4, 6, 8 vol.%

XPS analysis: surface and bulk

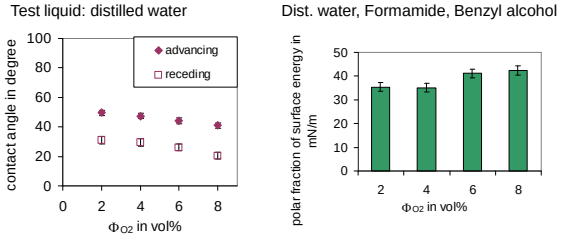




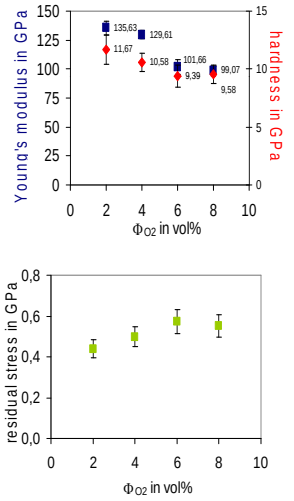
Raman spectroscopy



Dynamic contact angle measurement



Mechanical properties



Summary & Conclusions

With increasing gas flow Φ_{O2} the a-C:O coatings show **distinct features**. The O_2 gas flow correlates well with coatings properties:

- increasing O content in bulk (up to 8 at.%)
- fraction of sp^3 hybridized C atoms decreases
- sp^2 cluster size increases
- formation of ring structures favoured
- smooth surfaces, but R_t value increases
- mechanical properties deteriorate
- reduced contact angles
- polar fraction of surface energy increases

O content to be limited – advanced surface properties through ion bombardment, modified plasma chemistry and/or micro-patterning.