Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

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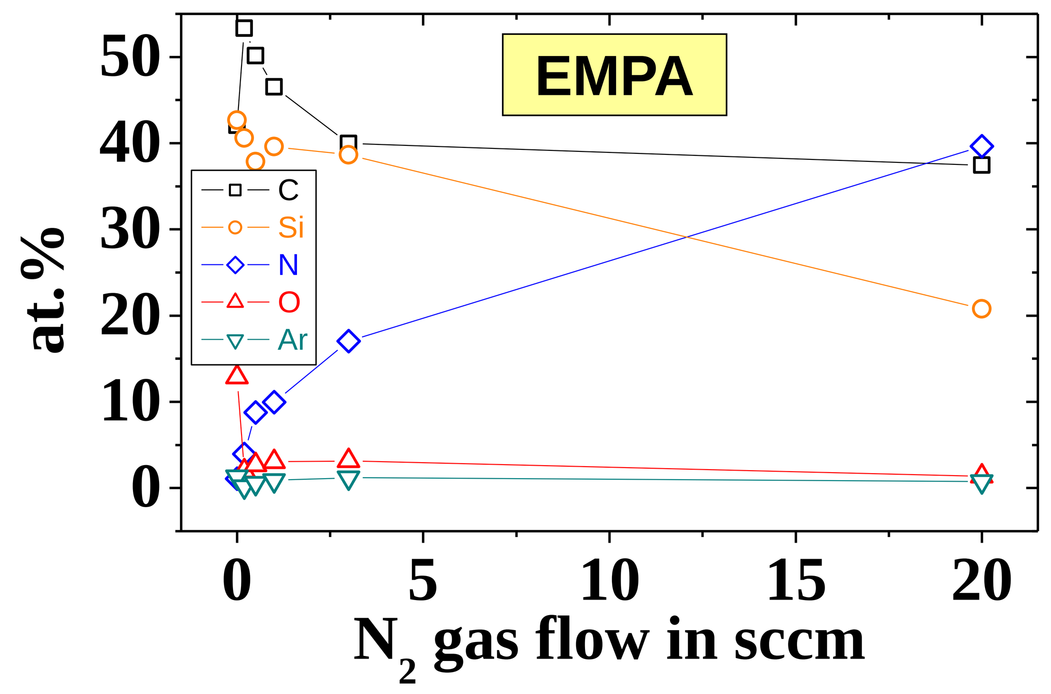
Constitution, microstructure and mechanical properties of sputtered nanocrystalline Si-C-N films as a function of nitrogen content

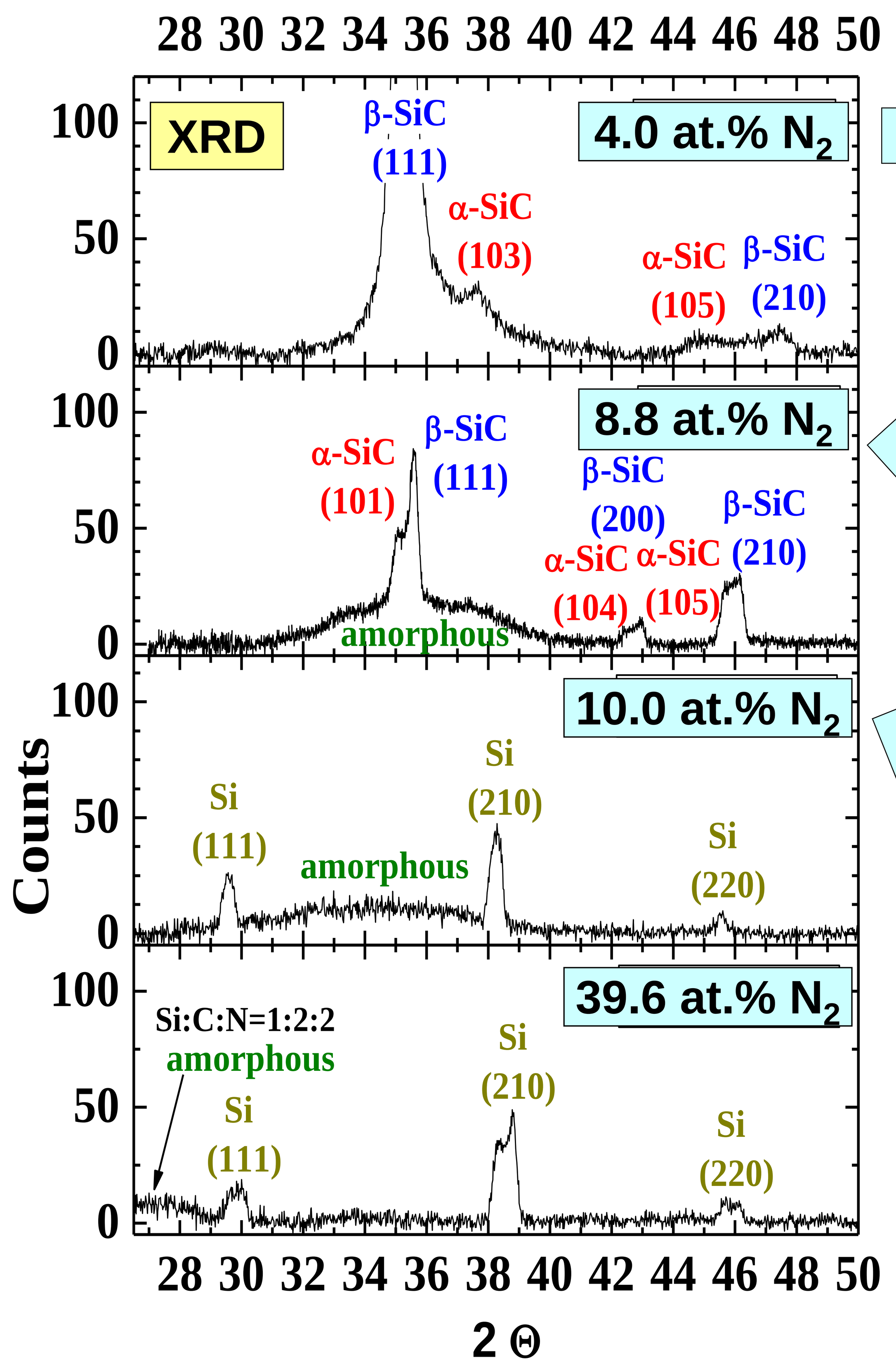
Deposition

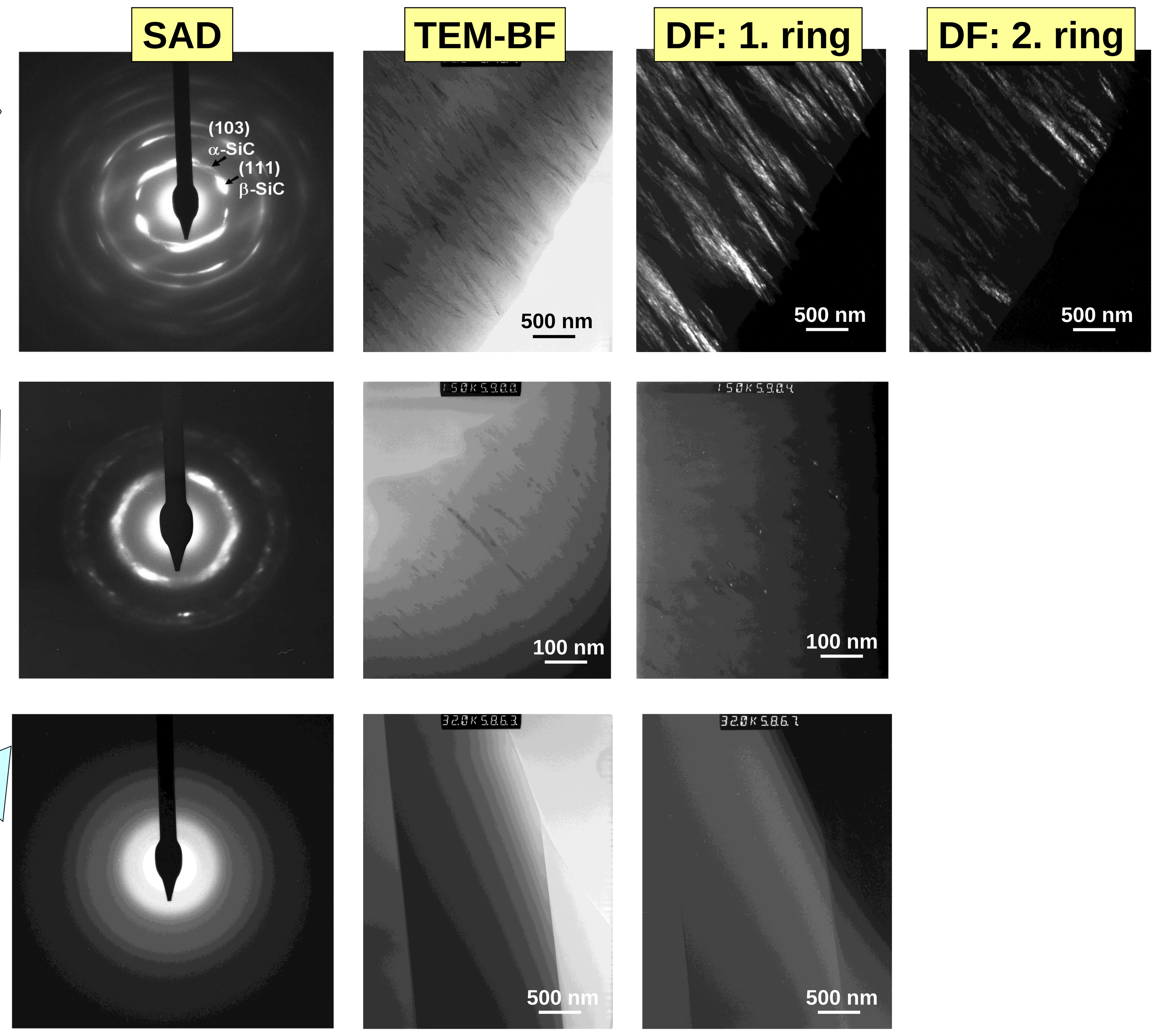
- RF magnetron sputtering from a SiC target in an Ar/N_2 atmosphere (T_s = 800 °C, U_s = 0 V) on Si substrates
- N_2 gas flow: 0 - 20 sccm

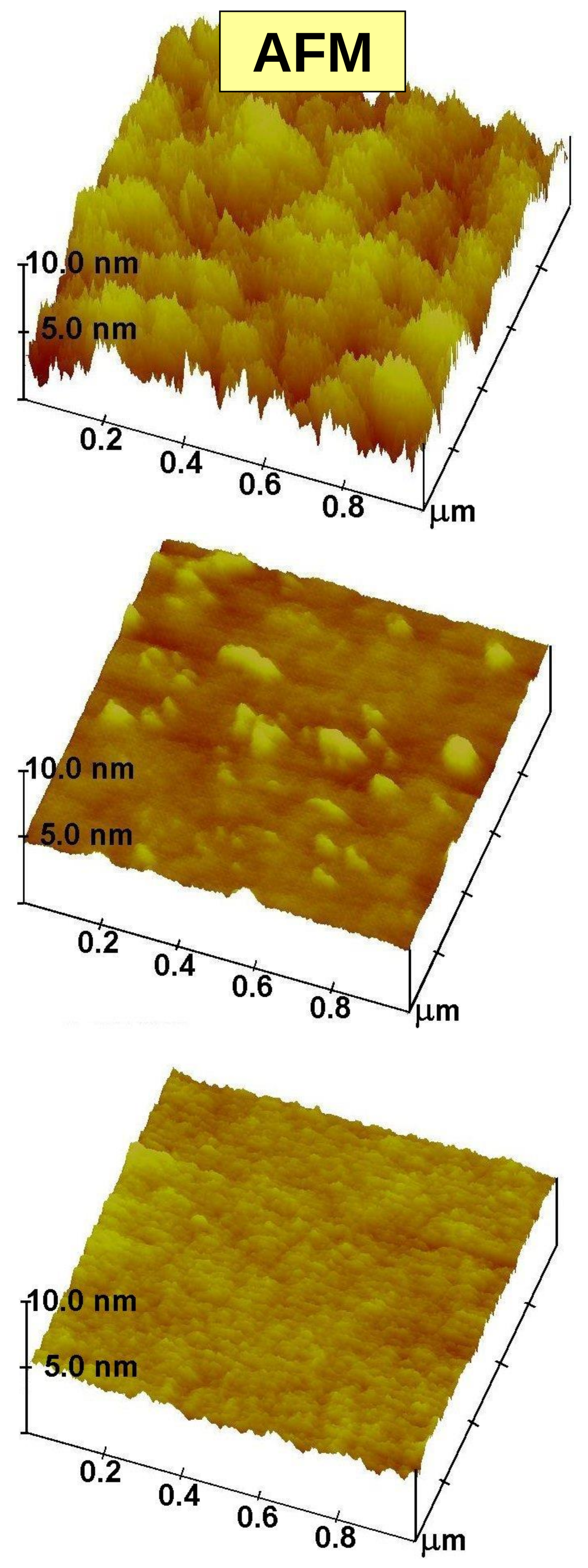
Composition



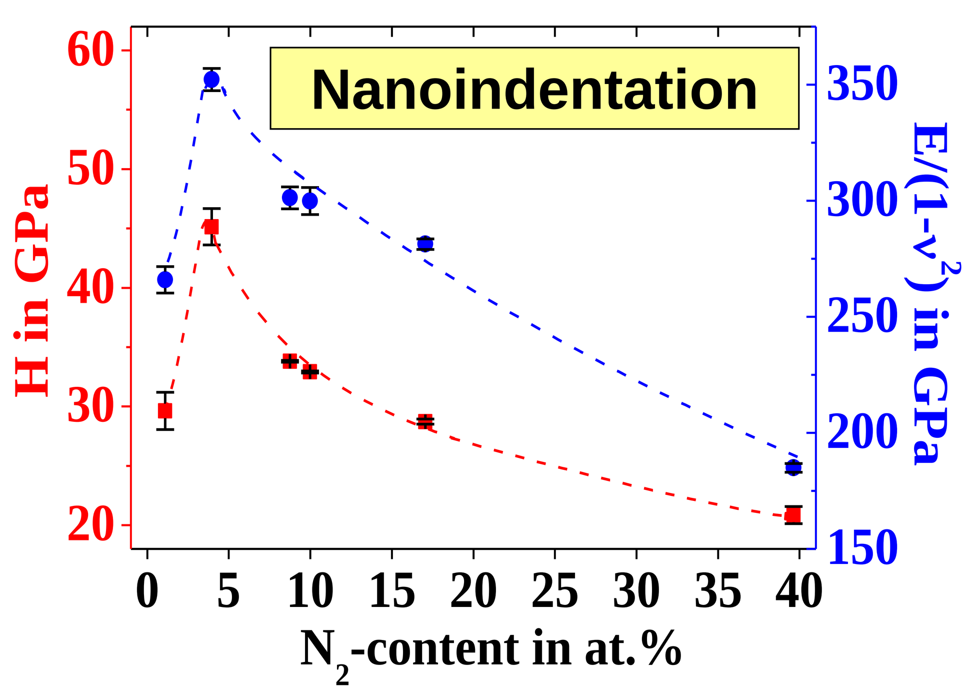
Microstructure and surface topography

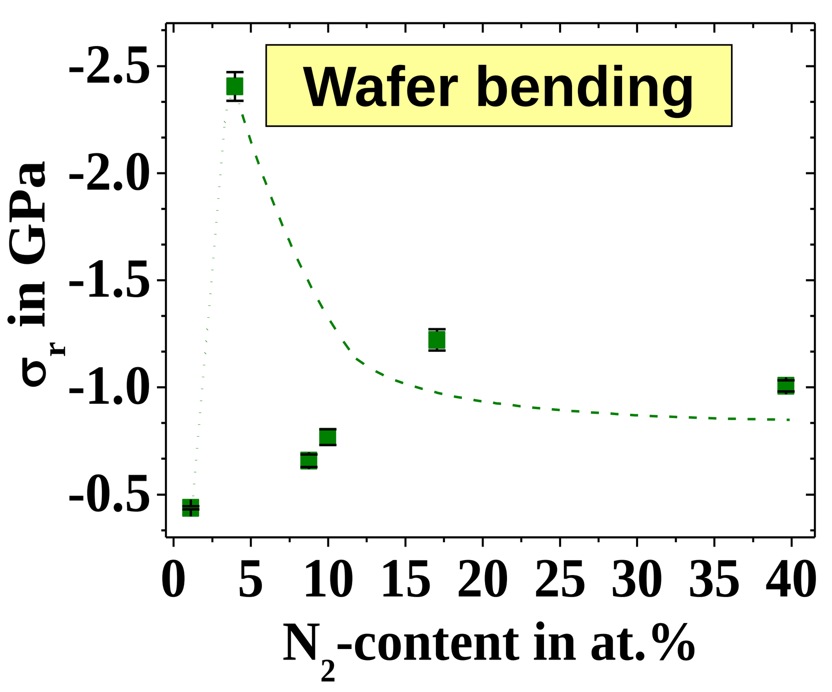


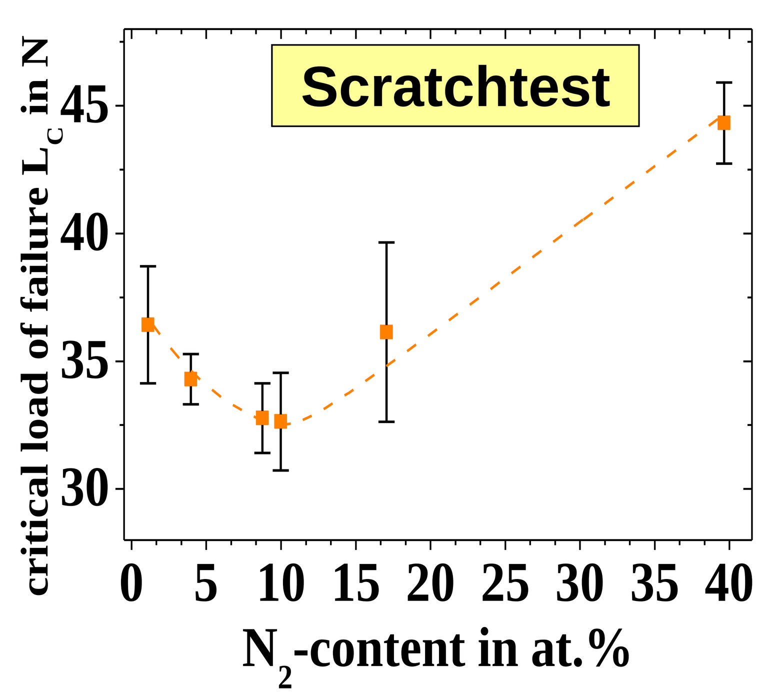


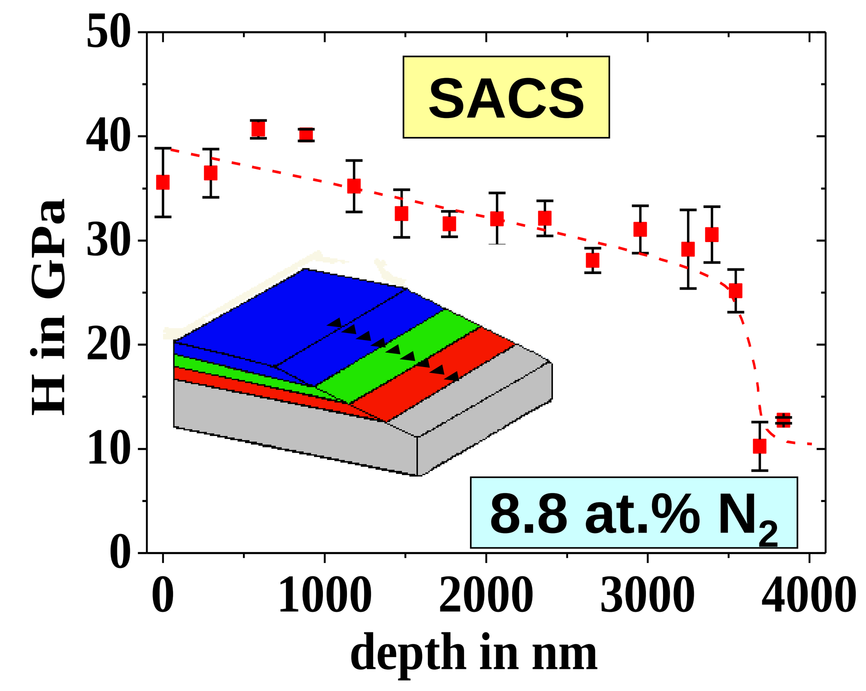


Mechanical properties









Summary

The nitrogen gas flow was systematically varied between 0 and 20 sccm to investigate its influence on the constitution, the microstructure and the mechanical properties. The films deposited without nitrogen flow were amorphous. At a low nitrogen content of 4.0 at.% in the film, a two-phase microstructure of phases close to α-SiC and β-SiC with nanocrystalline grains of 5-10 nm is formed. This nanostructure results in a superhard film with a hardness value of 45 GPa, however the residual stress also rises up from -0.6 to -2.4 GPa and the average surface roughness R_a increases from 0.2 to 0.9 nm. At nitrogen contents above 8.8 at.% the films become amorphous and the global composition changes from Si:C:N = 2:2:1 at 17.0 at.% N_2 to Si:C:N = 1:1:2 at 39.6 at.% N_2. This is accompanied by a drastic decrease in hardness down to 20 GPa.