TU Clausthal

DS 31.3

Influence of O_2/N_2 Gas Compositions on PECVD deposited Silicon Oxide Films

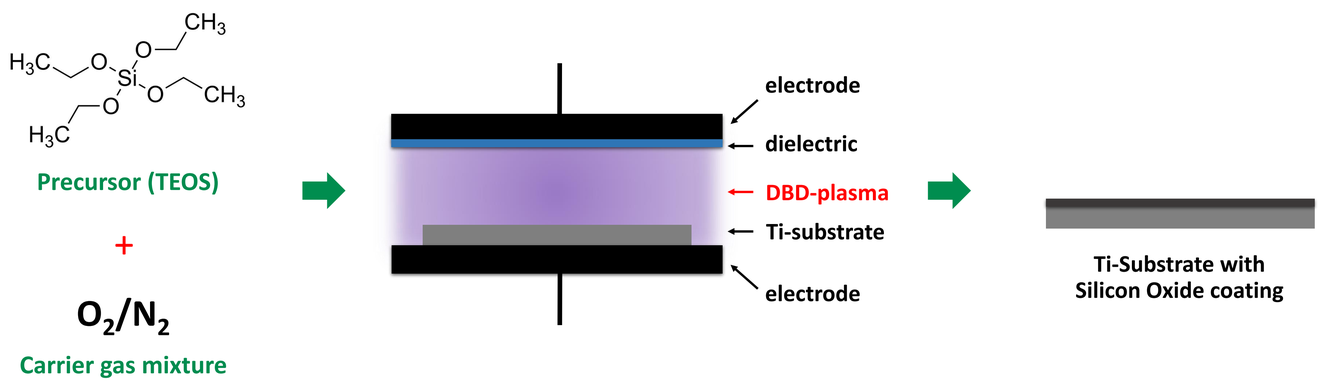
P. Moritz[1,2], S. Homann[1,2], L. Wurlitzer[1,2] and W. Maus-Friedrichs[1,2]

[1]Institute for Energy Research and Physical Technology, Clausthal University of Technology, Leibnizstraße 4, D-38678 Clausthal-Zellerfeld, Germany
[2]Clausthal Centre of Material Technology, Clausthal University of Technology, Agricolastraße 2, D-38678 Clausthal-Zellerfeld, Germany

Introduction

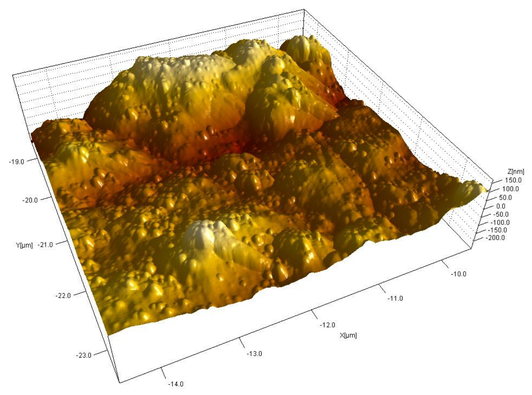
TiO_2 nanoparticles show a high photocatalytic activity and are used in the semiconductor industry or medicine for example. During the manufacturing process problems like agglomeration or phase transition at higher temperatures occure. Therefore the idea of this project is to cover the TiO_2 nanoparticles with a silicon oxide coating in order to increase the temperature stability and to avoid agglomeration.
In the experiments a titanium substrate with a native oxide layer is covered with SiO_x in a PECVD process. In order to this the substrate was exposed to the precursor TEOS with a carrier gas mixture of O_2 and N_2. Due to the dielectric barrier discharge the TEOS reacts and builds a solid film of silicon oxide. The aim is to find the ideal O_2/N_2 ratio for a homogenous deposition of SiO_x in layers.
The thin films are studied with microscopic (AFM) and spectroscopic (XPS) methods in order to investigate the morphology and the stochiometry of the deposition.

Experimental setup – PECVD process

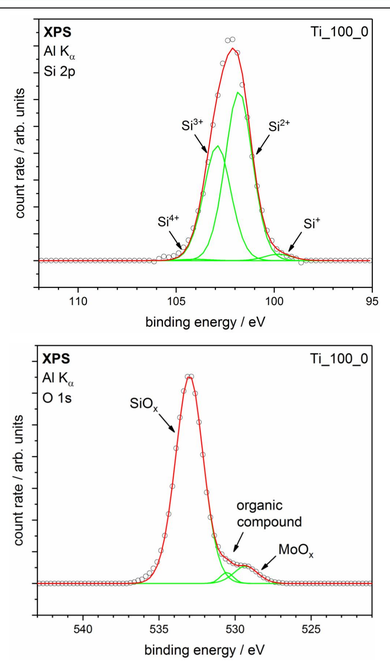


- Closed reaction chamber
- Gas flow rate: 5.20 ln/min
- High AC voltage: amplitude 13 kV, frequency 5 kHz
- Discharge distance: 1 mm
- Plasma treatment time: 30 s
- Variation of the O_2/N_2 gas compositions

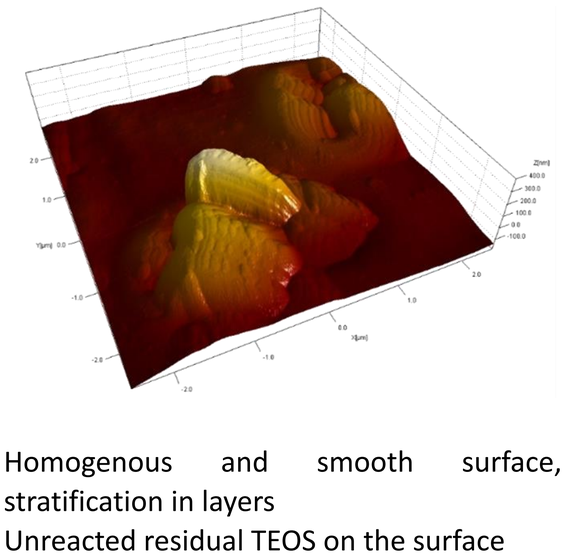
100 vol.% O_2



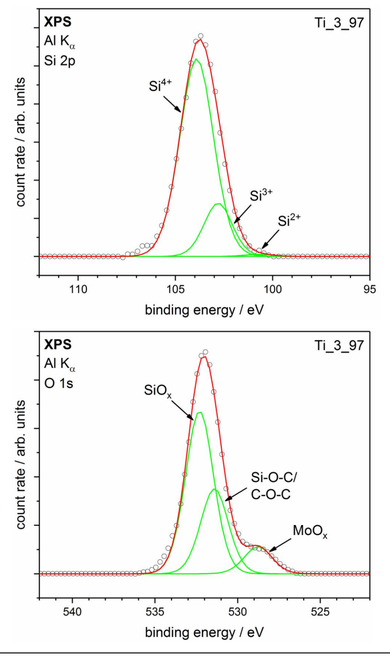
- Particulate deposition, 150 nm – 250 nm in diameter
- Formation of a SiO_x film, oxidation stage between +II and +III



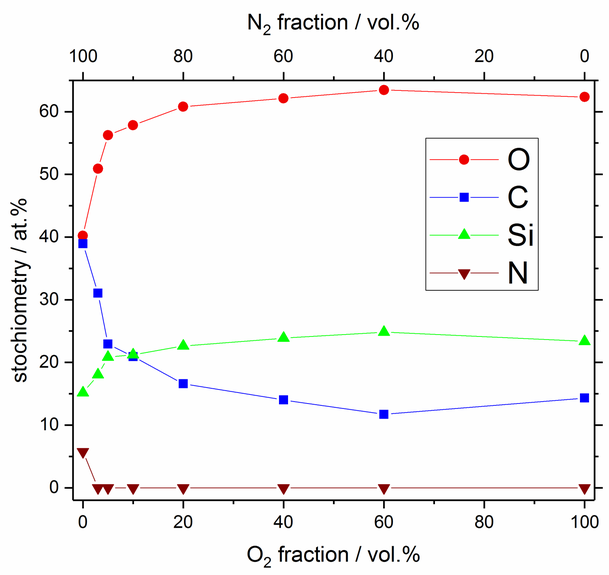
3 vol.% O_2



- Homogenous and smooth surface, stratification in layers
- Unreacted residual TEOS on the surface



Overview



- **20 vol.% - 100 vol. % O_2:**
  - Constant deposition stoichiometry, formation of a mixed oxide SiO_x
  - Particulate deposition, 150 – 350 nm in diameter
- **≤ 10 vol.% O_2:**
  - Stochiometry strongly dependent on the O_2 content
  - Increasing amount of carbon due to unreacted residual TEOS
  - Higher deposition rate, no scoring due to polishing visible
  - Smooth surface, deposition in layers

Summary

- At least 20 vol.% O_2 in the carrier gas necessary to dissociate the TEOS completely
- Higher oxygen contents in the carrier gas cause a particulate deposition of SiO_x, no complete oxidation observable
- Further investigation of low O_2 contents in the carrier gas necessary to optimize the stoichiometry of the homogenous and smooth films

Institute for Energy Research and Physical Technology
Leibnizstraße 4, 38678 Clausthal-Zellerfeld
Tel.: + 49-(0)5323-72 2292
E-mail: philipp.moritz@tu-clausthal.de
www.iept.tu-clausthal.de

He* e⁻
Atom- und Molekülphysik an Oberflächen

Clausthaler Zentrum für Materialtechnik