**Nb₂O₅** AND TiO₂ THIN FILMS DEPOSITED BY PULSÉ MAGNETRON SPUTTERING OF CYLINDRICAL CERAMIC TARGETS

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**ABSTRACT**

Nb₂O₅ and TiO₂ thin films were sputtered on low-iron float glass with a cylindrical dual magnetron system equipped with substochiometric ceramic targets. The influence of the oxygen partial pressure and the pulse mode on the thin film properties was studied. Therefore the plasma excitation mode was varied between DC-DC, bipolar square wave and bipolar sine mode. The power density was set to approx. 25 kW/m². With increasing oxygen partial pressure and changing the pulse mode from bipolar to unipolar the films got a slightly columnar structure, thus leading to lower refractive indices and lower compressive film stress even up to tensile film stress.

**EXPERIMENTAL SETUP**

- Vertical in-line sputtering plant ILA 900 (max. homogenous substrate width of 600 mm)
- Cylindrical dual magnetron sputtering system (Bekaert, target length: 280 mm)
- Power supply: UBS-C2 (DC-DC, bipolar square wave, Hipotronics Big 100-50P bipolar sine wave)
- Cylindrical ceramic targets (GfE Fremat, Freiberg, plasma sprayed substochiometric Nb₂O₅ and TiO₂)
- Dynamic deposition (one pass)
- Substrate pre-treatment RF plasma etching process (13.56 MHz)
- Film thickness approx. 200 nm
- Low-iron float glass with a thickness of 3.2 mm and thin glass slides for stress measurement

**OPTICAL AND STRUCTURAL PROPERTIES**

- Nb₂O₅: 200 nm, refractive index and mechanical stress vs. ratio of oxygen to argon
- TiO₂: 200 nm, refractive index and mechanical stress vs. ratio of oxygen to argon

**SUMMARY AND CONCLUSIONS**

The conclusion is that at a higher oxygen partial pressure and at a lower energetic input (DC-DC mode) the films are characterized by:

- **lower refractive indices**
- **lower compressive film stress even up to tensile film stress**
- **slightly more columnar appearance**

In summary the investigated thin films are suitable for optical coatings due to their transparency, high refractive index and mechanical film stress.

**CONTACT**

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**SPUTTERING PROCESS**

Process parameters: TiO₂, Nb₂O₅
- **power density**: 25 kW/m²
- **spattering pressure**: 0.1 Pa
- Additional oxygen: 0 ... 15% relative to argon
- **bipolar frequency**: 20 kHz
- **bipolar square wave**: 50 ... 110 kHz
- **deposition rate**: 60 ... 110 nm/min
- **arc density**: below 1 arc/mm² at 20 kHz
- **arc density**: for TiO₂ lower than for Nb₂O₅ targets
- **DC-DC mode** with moderate arc density (max. 4 arc/mm²)
- **deposition rate in bipolar mode** below DC-DC mode due to losses in polarity switches
- **deposition rate**: drops when oxygen added
- **variation of pulse mode and oxygen content**

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