Oxides grown by Atomic Layer Deposition for applications in electronics, optoelectronics, biology and medicine

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ALD growth process
Adsorption of first precursor
Surface saturation followed by reactor purging
CVD

- Less reactive precursors
- Precursors react at the substrate but also before deposition
- Precursors can decompose at process temperature
- Uniformity requires uniform flux reactant and temperature
- Thickness control by precise process control and monitoring

ALD

- Highly reactive precursors possible
- Precursors react only on the substrate of the film
- Precursors must not decompose at process temperature
- High uniformity of coating ensured by the saturation mechanism
- Good thickness control by selecting the number of ALD cycles
- Uniform doping of the layers possible
- Reactor scaling possible
- Multisubstrate deposition possible
Benefits of the LT growth – Hybrid structures
Electrical Characterization

- Improved junction behavior in terms of \( I_{\text{off}} \)
- \( I_{\text{on}}/I_{\text{off}} \sim 10^5 \), \( I_{\text{on}}/I_{\text{off}} \)
- High current density: \( J = 10^4 \text{A/cm}^2 \) at 4V (\( J = 0.02 \text{A/cm}^2 \) for a P3HT diode)
Photovoltaic diode based on ZnO/NiPc junction

Effect of ZnO layer on device stability

Time stability

G. Łuka

As prepared

After 30 days
Advantages of LT growth
Transparent electronics
Electrical behavior of zinc oxide layers grown by low temperature atomic layer deposition

N. Huby\textsuperscript{a}) and S. Ferrari
MDM-INFM, 2 via camillo Olivetti, 20041 Agrate Brianza, Italy

E. Guziewicz, M. Godlewska, and V. Osinniy
Institute of Physics, Polish Academy of Sciences, Warsaw 02668, Poland
Spintronics

Uniformity of DMS samples - the most critical issue
Uniform Zn(Mn,Co)O layers by ALD

Ratio of the ALD cycles

Uniform ZnCoO layers

ZnCoO
Antibacterial coating
Antibacterial coating
Photovoltaics
TCO films based on ZnO:Al
ZnO TCO metodą ALD

G. Łuka, R. Pietruszka, Ł. Wachnicki
Photovoltaics
New architecture
Conformal coating of 3D structures- Nanowires of ZnTe coated with ZnO
ZnTe nanowires on (100) oriented substrate

ZnO coated nanowires

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nanorods GaN on Si(111) coated with ZnO („shell” ALD)

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Summary:

1. Low temperature processes – range of hybrid structure possible
2. Conformal coating of developed surfaces – 3D structures
3. High quality of deposited material – High-k oxides with excellent properties