

Contents <http://www.cvd-journal.de>

Cover image from M. M. Shawrav, H. D. Wanzenboeck, and co-workers (*Chem. Vap. Deposition* **2014**, 20, 251)

The cover image illustrates the use of focused-electron-beam-induced CVD to directly write nanostructures with nanometer resolution. The Au-Fe nanoalloys produced have potential applications in nanoelectronics.

Editorial: Special Issue: Preface to the CVD Special Issue: Atomic-Scale-Engineered Materials (ASEM)

A. Devi, W. M. M. Kessels

Chem. Vap. Deposition **2014**, 20, 186 ... 188

Review: This review provides a brief description of ALD and presents studies on the deposition of thin films of groups 4 and 5 metal oxides using ALD. A description of the general ALD properties of homoleptic precursors, in addition to a review of the thermal ALD of groups 4 and 5 metal oxides from heteroleptic precursors, is presented. Trends in the properties of heteroleptic ALD precursors based on the literature review and recent experimental data are discussed.

T. Blanquart,* J. Niinistö, M. Ritala,
M. Leskelä

Chem. Vap. Deposition **2014**, 20, 189 ... 208

Atomic Layer Deposition of Groups 4 and
5 Transition Metal Oxide Thin Films: Focus
on Heteroleptic Precursors

Full Paper: Atomic layer deposition of TiO₂ and ZrO₂ is performed using heteroleptic amido/guanidinate metal precursors, and ozone and water as oxygen sources. The results are compared to previous studies and the effect of the ligands on the precursor properties are discussed.

M. Kaipio, T. Blanquart,* M. Banerjee,
K. Xu, J. Niinistö, V. Longo,
K. Mizohata, A. Devi,
M. Ritala, M. Leskelä

Chem. Vap. Deposition **2014**, 20, 209 ... 216

Atomic Layer Deposition of TiO₂ and
ZrO₂ Thin Films Using Heteroleptic
Guanidinate Precursors

Full Paper: The ALD processes for three novel precursors for the ALD of Er_2O_3 , namely $\text{Er}(\text{BuCp})_3$, $\text{Er}(\text{PrCp})_3$, and $\text{Er}(\text{MeCp})_2(\text{Pr-amd})$, are developed and the films are characterized. The first report of the conformal ALD growth of Er_2O_3 thin film on a high-aspect-ratio structure is also included.

T. Blanquart,* M. Kaipio, J. Niinistö, M. Gavagnin, V. Longo, L. Blanquart, C. Lansalot, W. Noh, H. D. Wanzanböck, M. Ritala, M. Leskelä

Chem. Vap. Deposition **2014**, 20, 217 ... 223

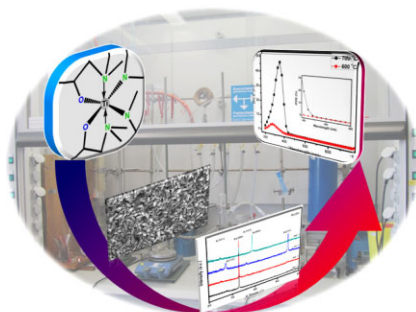
Cyclopentadienyl Precursors for the Atomic Layer Deposition of Erbium Oxide Thin Films

Full Paper: A Ti amide complex stabilized by a substituted aminoalcohol is synthesized for the first time. The compound exhibits promising thermal properties and is successfully applied as a MOCVD precursor for the growth of TiO_2 thin films. The new precursor is very efficient in terms of high growth rates, with the possibility of tuning the morphology by controlling the CVD process parameters, which is particularly important in regard to photoelectrochemical applications.

M. Banerjee, V.-S. Dang, M. Bledowski, R. Beranek, H.-W. Becker, D. Rogalla, E. Edengeiser, M. Havenith, A. D. Wieck, A. Devi*

Chem. Vap. Deposition **2014**, 20, 224 ... 233

MOCVD of TiO_2 Thin Films using a Heteroleptic Titanium Complex: Precursor Evaluation and Investigation of Optical, Photoelectrochemical and Electrical Properties

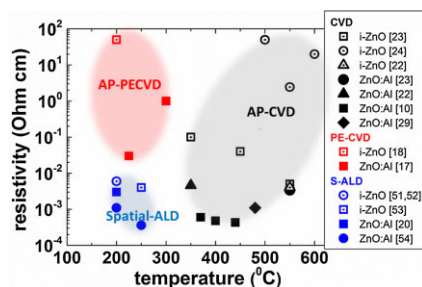


Review: New atmospheric vapor-phase deposition techniques are being developed to meet the industrial need for high-throughput and low-cost deposition processes. While atmospheric CVD is a mature technology, novel processes for the growth of transparent conductive oxides on thermally sensitive materials or flexible substrates are being developed, such as atmospheric PE-CVD and atmospheric spatial ALD. The challenges and recent results on the growth of ZnO by atmospheric CVD, PE-CVD, and spatial ALD are presented.

A. Illiberi, P. Poodt, P.-J. Bolt, F. Roozeboom*

Chem. Vap. Deposition **2014**, 20, 234 ... 242

Recent Advances in Atmospheric Vapor-Phase Deposition of Transparent and Conductive Zinc Oxide



Full Paper: Focused electron beam-induced deposition (FEBID) is used as a direct-write approach for the fabrication of Fe-based nanostructures on Si(100), starting from Fe(CO)₅. FEBID uses an electron beam to locally induce a CVD process. A systematic variation of FEBID parameters is performed to study their influence on the geometry and composition of the deposit. Based on the results, specific deposition conditions are suggested for nanomagnetic applications and the fabrication of large structures.

M. Gavagnin, H. D. Wanzenboeck,*
M. M. Shawrav, D. Belic, S. Wachter,
S. Waid, M. Stoeger-Pollach,
E. Bertagnolli

Chem. Vap. Deposition **2014**, 20, 243 ... 250

Focused Electron Beam-Induced CVD of Iron: a Practical Guide for Direct Writing

Full Paper: Focused electron beam-induced deposition is utilized to co-deposit gold and iron structures using dimethyl-gold(III)-trifluoroacetylacetonate and iron pentacarbonyl metal-organic precursors. The deposition rate and chemical composition of these direct-write Au-Fe nanoalloys can be controlled by varying the working pressures.

M. M. Shawrav, D. Belic, M. Gavagnin,
S. Wachter, M. Schinnerl,
H. D. Wanzenboeck,*
E. Bertagnolli

Chem. Vap. Deposition **2014**, 20, 251 ... 257

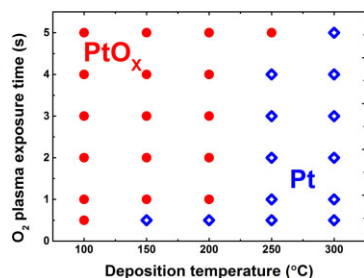
Electron Beam-Induced CVD of Nanoalloys for Nanoelectronics

Full Paper: Thin films and nanoparticles of PtO_x (2.5 < x < 2.7) are deposited by plasma-assisted ALD in a temperature window from room temperature to 300 °C by controlling the O₂ plasma and (MeCp)PtMe₃ exposure. With increasing substrate temperature, the thermal stability of PtO_x is found to decrease and the reducing activity of the precursor ligands is found to increase. The material properties of the PtO_x films are studied and it is shown that a film conformality of 90% can be achieved in trenches with an aspect ratio of 9.

I. J. M. Erkens, M. A. Verheijen,
H. C. M. Knoops, T. F. Landaluce,
F. Roozeboom, W. M. M. Kessels*

Chem. Vap. Deposition **2014**, 20, 258 ... 268

Plasma-Assisted Atomic Layer Deposition of PtO_x from (MeCp)PtMe₃ and O₂ Plasma



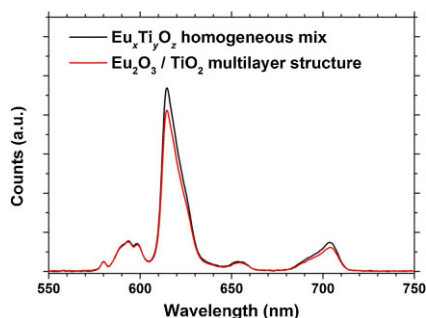
Full Paper: Thin films of Ca-doped LaPO₄ are produced using ALD with La(thd)₃, (CH₃)₃PO₄, H₂O, and O₃ as precursors. The films are studied using X-ray based techniques and TEM. The requirement of a mixed O₃/H₂O precursor for the growth of the phosphate is studied in detail using QCM.

H. H. Sønsteby, E. Østreng, H. Fjellvåg,
O. Nilsen*

Chem. Vap. Deposition **2014**, 20, 269 ... 273

Atomic Layer Deposition of LaPO₄ and Ca:LaPO₄

Full Paper: The luminescence properties of amorphous europium titanium oxide thin films grown by atomic layer deposition are investigated as a function of Eu_2O_3 and TiO_2 layer thicknesses, varying from a homogeneous mixture to 2.9 nm repeating layer structures. Samples ranging from homogeneous to 0.8 nm repeating layers are optically similar while the luminescence intensity decreases for thicker layers.



P.-A. Hansen, H. Fjellvåg, T. G. Finstad, O. Nilsen*

Chem. Vap. Deposition **2014**, *20*, 274 ... 281

Luminescent Properties of Multilayered Eu_2O_3 and TiO_2 Grown by Atomic Layer Deposition

Full Paper: The resistive switching of $\text{TiO}_x/\text{Al}_2\text{O}_3$ bilayers integrated in μ -crossbar devices is investigated for future ReRAM. The bilayer stack is realized in consecutive atomic layer depositions (ALD) at 300 °C. Amorphous Al_2O_3 films exhibit a dielectric permittivity of 8.0 and disruptive field strength of 7 MV cm^{-1} , whereas the oxygen-deficient TiO_x is semiconducting. The bipolar-type resistive switching characteristics of $\text{TiN}/\text{TiO}_x/\text{Al}_2\text{O}_3/\text{Pt}$ cells show a strong dependence on both oxide layer thicknesses.

H. Zhang, N. Aslam, M. Reiners, R. Waser, S. Hoffmann-Eifert*

Chem. Vap. Deposition **2014**, *20*, 282 ... 290

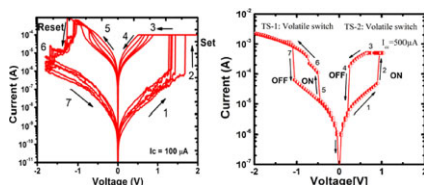
Atomic Layer Deposition of $\text{TiO}_x/\text{Al}_2\text{O}_3$ Bilayer Structures for Resistive Switching Memory Applications

Full Paper: Nanoscopic VO_x coatings are produced by atomic layer deposition for resistive random access memory devices. The devices show bipolar switching behavior with resistance ratio $R_{\text{OFF}}/R_{\text{ON}} > 10^3$ whereas, at higher electroforming voltage (4 - 5 V), threshold switching behavior is observed.

T. Singh, S. Wang, N. Aslam, H. Zhang, S. Hoffmann-Eifert, S. Mathur*

Chem. Vap. Deposition **2014**, *20*, 291 ... 297

Atomic Layer Deposition of Transparent VO_x Thin Films for Resistive Switching Applications



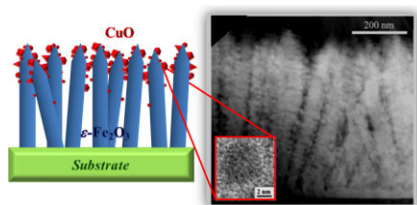
Review: A thermodynamic analysis is performed to comment on the stability of vanadium oxide structures based on the calculated formation energies. The structure-related properties of the identified stable and metastable compounds are discussed, with an emphasis on the reported functional applications. Finally, the established gas-phase chemical deposition processes for the growth of vanadium oxide compounds are reviewed, referring to the type of precursors used.

N. Bahlawane,* D. Lenoble

Chem. Vap. Deposition **2014**, *20*, 299 ... 311

Vanadium Oxide Compounds: Structure, Properties, and Growth from the Gas Phase

Full Paper: A two-step synthetic strategy for the synthesis of $\text{Fe}_2\text{O}_3/\text{CuO}$ composites is presented. The approach consists of the growth of $\epsilon\text{-Fe}_2\text{O}_3$ by CVD, followed by copper sputtering and annealing in air. A multi-technique characterization showed $\epsilon\text{-Fe}_2\text{O}_3$ nanorod arrays possessing an intimate contact with nanometer-sized CuO particles, the loading and dispersion of which can be tuned as a function of the process duration..



D. Barreca,* G. Carraro, D. Peeters, A. Gasparotto, C. Maccato, W. M. M. Kessels, V. Longo, F. Rossi, E. Bontempi, C. Sada, A. Devi

Chem. Vap. Deposition **2014**, 20, 313 ... 319

Surface Decoration of $\epsilon\text{-Fe}_2\text{O}_3$ Nanorods by CuO Via a Two-Step CVD/Sputtering Approach

Full Paper: ZrO_2 thin films are deposited by metal-organic (MO)CVD using the precursor $(\text{Zr}(\text{NMe}_2)_2(\text{guan})_2)$ as the Zr source, together with oxygen. Functional properties, including the optical, electrical, and mechanical properties, of the resulting ZrO_2 films are investigated.

V.-S. Dang,* M. Banerjee, H. Zhu, N. B. Srinivasan, H. Parala, J. Pfetzing-Micklich, A. D. Wieck, A. Devi

Chem. Vap. Deposition **2014**, 20, 320 ... 327

Investigation of Optical, Electrical, and Mechanical Properties of MOCVD-grown ZrO_2 Films