TiO$_2$ and Al$_2$O$_3$ ALD Grown Multilayers for Subwavelength Photonics

Shkondin, Evgeniy; Jensen, Flemming; Lavrinenko, Andrei; Mar, Mikkel Dysseholm; Larsen, Pernille Voss; Malureanu, Radu; Zhukovsky, Sergei V.; Andryieuski, Andrei A.; Takayama, Osamu

Published in:
Book of Abstracts. DTU's Sustain Conference 2015

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Links back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
TiO$_2$ and Al$_2$O$_3$ ALD Grown Multilayers for Subwavelength Photonics.

Evgeniy Shkondin*1, Flemming Jensen2, Andrei Lavrinenko3, Mikkel Dysseholm Mar4, Pernille Voss Larsen5, Radu Malureanu6, Sergei V. Zhukovsky7, Andrei A. Andryieuski8, Osamu Takayama9

1: DTU Danchip, DTU Fotonik; 2: DTU Danchip; 3: DTU Fotonik; 4:-5: DTU Danchip, 6:-9: DTU Fotonik
*eves@fotonik.dtu.dk

Atomic Layer Deposition (ALD) is playing a steadily increasing role in micro- and nanofabrication technologies. This is also the case for many applications within sustainability such as solar cells, energy harvesting in general and efficient micro-power solutions where ALD offers new tailor-made material compositions, highly conformal deposition and excellent control over layer thickness and uniformity [1].

ALD allows deposition of nanometer scale thin multilayer coatings, which can be used in fields of optics and nanophotonics [2]. Recent theoretical publications [3], [4] suggest that well-defined effective media approximation (EMA) [5] assumption may fail in transparent dielectric multilayers with deep subwavelength thicknesses. The transmission spectrum in this case becomes different than predicted by EMA. The spectrum becomes sensitive to layers thicknesses on nanometer scale and their order in multilayer. In this work we present the fabrication approach to the described structure.

TiO$_2$ and Al$_2$O$_3$ metal oxides were selected as the multilayer components. The fabrication of the multilayers was performed in a commercial hot-wall ALD system (Picosun R200, Finland). The precursors used for Al$_2$O$_3$ and TiO$_2$ deposition were trimethylaluminum Al(CH$_3$)$_3$ and titanium tetrachloride (TiCl$_4$), respectively. An oxidant source in both processes was deionized water. The deposition temperature was chosen at 120°C in order to prevent the anatase phase transition of TiO$_2$ known to occur at temperatures above 150°C [6]. The deposition of Al$_2$O$_3$/TiO$_2$ multilayers was carried on 100mm <100> silicon wafers. After the ALD process was completed, the sample was cleaved and its cross-section was characterized using scanning electron microscopy (SEM). The SEM images reveal high-quality homogeneous, conformal coatings, as seen in the examples in Figs 1 and 2.

We believe this fabrication flow opens possibility for experimental demonstration of EMA theory breakdown in deep subwavelength multilayers. This technology can be applied for developing of variety of new optical sensing and switching applications.

References: