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

Publication date:
2015

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

TiO_2 and Al_2O_3 ALD Grown Multilayers for Subwavelength Photonics.

Evgeniy Shkondin*[1], Flemming Jensen[2], Andrei Lavrinenko[3], Mikkel Dysseholm Mar[4], Pernille Voss Larsen[5], Radu Malureanu[6], Sergei V. Zhukovsky[7], Andrei A. Andryieuski[8], Osamu Takayama[9]

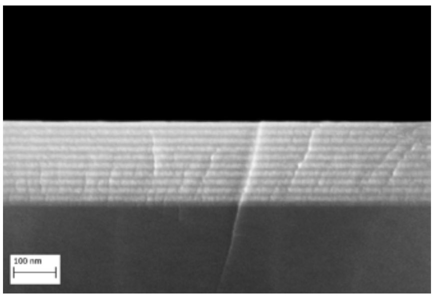
1: DTU Danchip, DTU Fotonik; 2: DTU Danchip; 3: DTU Fotonik; 4:-5: DTU Danchip, 6:-9: DTU Fotonik

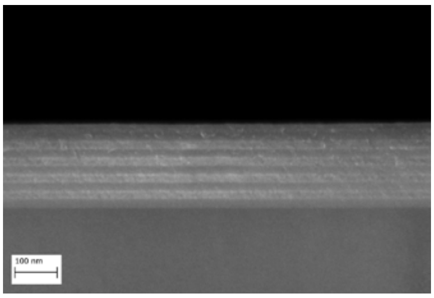
*eves@fotonik.dtu.dk

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_2O_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_2O_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 120C in order to prevent the anatase phase transition of TiO_2 known to occur at temperatures above 150C [6]. The deposition of Al_2O_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.

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