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TiO₂ and Al₂O₃ ALD Grown Multilayers for Subwavelength Photonics.

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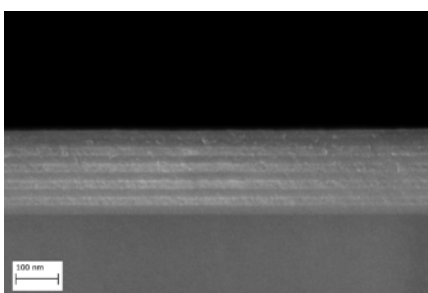
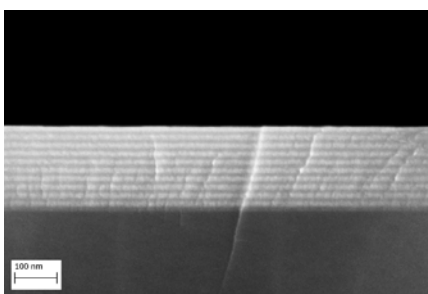
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Atomic Layer Deposition (ALD) is playing a steadily increasing role in micro- and nanofabrication technologies. This is also the case for many applications within sustainability such as solar cells, energy harvesting in general and efficient micro-power 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.

TiO₂ and Al₂O₃ 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 Al₂O₃ and TiO₂ deposition were trimethylaluminum Al(CH₃)₃ and titanium tetrachloride (TiCl₄), 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 TiO₂ known to occur at temperatures above 150C [6]. The deposition of Al₂O₃/TiO₂ 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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