Micro and Nano Structured Oxide Features Made by Femtosecond Laser Ablation, Reactive Ion Etching and Lithography

Johann Zehetner, Stephan Kasemann, Stefan Partel

Research Centre for Microtechnology, University of Applied Sciences, Hochschulstrasse 1, 6850 Dornbirn, Austria

E-mail: johann.zehetner@fhv.at

Abstract. Metal oxides are essential basic materials for electrochemical sensors, photocatalytic devices, solar cells and optical meta-surfaces. For such sensor devices hierarchical structures are often used to provide the required high surface area facilitating effectively the specific function of the semiconducting metal oxides. Laser ablation of metals is less complicated than direct structuring of oxide films. We demonstrate that such a laser generated metal formation can serve as an etch mask for reactive ion etching (RIE) and that it is possible to subsequently convert the fabricated metal features to the desired oxide by chemical or thermal procedures. To illustrate the design opportunities of the process we produced box shaped structures and hollow needles of 10 µm in diameter with an Al crest of submicron wall thickness by laser ablation combined with RIE (Fig. A). Only ablation on glass was used to fabricate the transparent pyramid assemble with the open TiO_2 structure of 500 nm wall thickness (Fig. B). Figure C depicts a Fresnel lens like structure. A 100 nm Ti coating was deposited using PVD and then structured by lithography and lift off technique, followed by a chemical oxidation step to generate a transparent lens. The obtained oxide was very homogeneous and smooth. In contrast the insert in Fig. C shows the resulting crystal morphology of a laser treated and thermally oxidized Al layer of 200 nm. This transparent sample showed a dense dot pattern (dot diameter 2 to 5 µm) with reduced reflection for visible light. We are currently investigating the cause of such a reflection quality and the possibility for sensor application.