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Laser surface treatment of porous ceramic substrate for application in solid oxide fuel cells

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Abstract. Laser has offered a large number of benefits for surface treatment of ceramics due to possibility of localized heating, very high heating/cooling rates and possibility of growth of structural configurations only produced under non-equilibrium high temperature conditions. The present work investigates oxidation of porous ZrB_2-SiC sintered ceramic substrates through treatment by a 1072 ± 10 nm ytterbium fiber laser. A multi-layer structure is hence produced showing successively oxygen rich distinct layers. The porous bulk beneath these layers remained unaffected as this laser-formed oxide scale and protected the substrate from oxidation. A glassy SiO_2 structure thus obtained on the surface of the substrate becomes subject of interest for further research, specifically for its utilization as solid protonic conductor in Solid Oxide Fuel Cells (SOFCs).

1. Introduction

Nowadays, laser has become an alter native tool for materials processing, in particular for surface modification of refractory ceramics. However, the laser involvement on the treatment of structural ceramics for the purpose of protonic conducting fuel cell electrodes is still in initial stage.

As known, typical physical phenomenon occurs during laser-ceramic interaction such as heating, surface melting, surface vaporization, plasma formation and ablation [1]. These phenomena provide various treatments on the samples. One of the desirable lasers for surface treatment is ytterbium fiber laser (Yb-fiber laser).According to M. N. Zervas [2], high power Yb-fiber laser has been drawing attention to the material processing and other industrial applications. This due to their attractive features such as higher energy conversion efficiency (> 30 %), which is more than yttrium aluminium garnet (YAG) or CO_2 lasers [3–5] and finally the most highlighted feature is high heat localization that lead to higher precision of customizing product.

Several studies have reported Yb-fiber laser as a major tool for various properties modification such as electrical, mechanical, chemical and thermal. Study by Boutinguiza et al. [6] has reported that pulsed Yb-fiber laser ablation can be used to synthesize titanium oxide (TiO_2) at controllable size nano particles. In addition, they have also reported that the laser can be employed for formation of nano particles in solutions with reduced contamination, high particle collection, ease of preparation, low costs of processing and eventually many kind of colloidal nano particles can be obtained [6].

Meanwhile, other researchers [3–5] have employed laser particularly for the modification of physical properties of ceramics and morphology modification. The most recent study is on