TRIGGERING THE CATALYTIC ACTIVITY OF SrTiO3-BASED CERAMICS BY FLASH SINTERING

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Confinement of charge carriers in nanoscopic systems has revealed to be an effective strategy to confer ceramic materials unconventional conductive properties by exploiting particle size effects and interfaces characteristics[1]. Strontium titanate ($SrTiO_3$) is a piezoelectric oxide that requires to be doped by acceptor species (e.g. Fe substitution of Ti centers) in order to acquire fair chemical reactivity[2].

In the present work, we show how chemically inert $SrTiO_3$ and $La_{0.1}Sr_{0.9}TiO_3$ ceramics can be turned into active materials by improving the concentration and reactivity of the ionic species using electric-field-assisted treatments[3]. Flash sintering is a novel, sustainable consolidation technology able to massively reduce the process time and cost with respect to conventional treatments, by applying an external electric field to a ceramic sample upon heating. $SrTiO_3$-based nanoparticles of 50 nm were prepared by a green hydrothermal synthesis and treated under air using flash and conventional sintering methods. The consolidation in presence of an electric field arrested the grain growth, retained the specific surface area and enhanced the concentration of Sr vacancies and O^- species. Moreover, the confinement of such ionic defects in mesoscopic particles contributed to a significant improvement of the charge carrier mobility, but to a general decrease of the total conductivity. The effect of these electric-field-induced properties was tested with respect to the total catalytic oxidation of methane, used as high temperature, exemplary test. Flash sintered materials exhibited more than 95% of methane conversion at 800 °C, with performance over 3 times higher than for the conventionally treated material and other donor-doped perovskites.

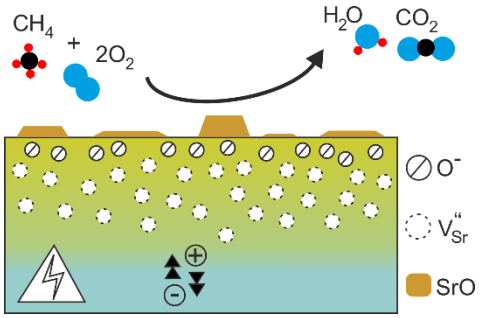

Figure 1 – Illustration of the peculiar defect nature of flash sintered $SrTiO_3$-based materials

The employment of field-assisted processing technologies can be therefore considered as an attractive forward-looking strategy for the development of functional ceramics with innovative properties by exploiting the confinement effect of charge carriers in mesoscopic systems.

References:

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