Forschungszentrum Karlsruhe
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TECHNISCHE UNIVERSITÄT DARMSTADT

Nanopowder of Sr-doped Lanthanum Manganite via Spray Pyrolysis for SOFC Applications

Azad Jaberi Darbandi [1], Hermann Sieger [1] and Horst Hahn [1,2]

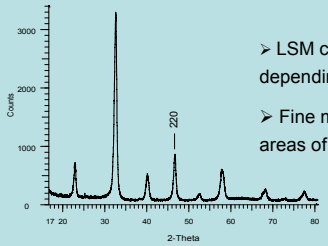
[1] Gemeinschaftslabor Nanomaterialien, Forschungszentrum Karlsruhe / Technische Universität Darmstadt
[2] Institut für Nanotechnologie, Forschungszentrum Karlsruhe

Introduction:

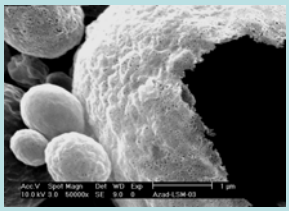
The electrochemical properties of Sr-doped Lanthanum Manganite (LSM) cathode layers of Solid Oxide Fuel Cells (SOFC) depend largely on the microscopic features of the triple point boundaries (TPB), which in turn depend on the starting precursor powder characteristics such as particle size, shape and their distribution. Hence, optimization of the mircostructure of the cathode layer is of prime importance in enhancing the electrochemical performance of the cathode.

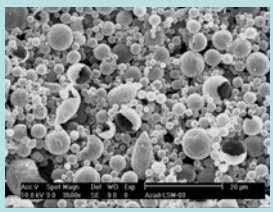
As prepared LSM powder via spray prolysis

Synthesis of LSM powder via spray pyrolysis of nitrate citrate solution leads to porous hollow spheres with very thin shells.



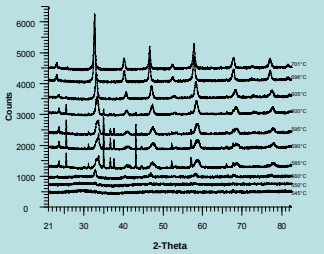
- LSM crystallite sizes in the range of 9-14 nm depending on synthesis temperature
- Fine mircostructure with high specific surface areas of 32 up to 70 m^2/g



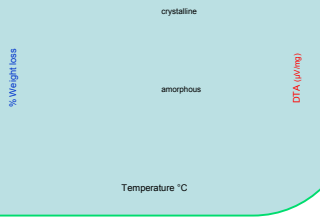


Evolution of perovskite structure

In-situ X-Ray diffraction of amorphous powder synthesized at low temperature shows that the crystallization starts at 560°C and the evolution of single phase perovskite structure is completed at 625°C.

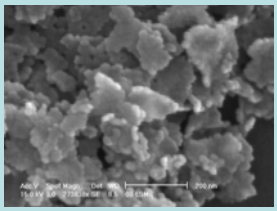


In order to follow the crystallization process in the amorphous powder thermogravimetry analysis was carried out. This indicates that the crystallization is combined with burnout of organics. The crystalline powder exhibits neither weight loss nor exothermic peak.



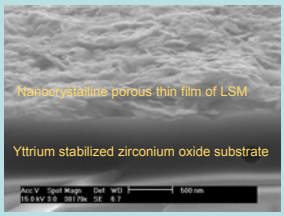
Preparation of porous thin film of nanocrystalline LSM

As prepared LSM powder containing hollow spheres with thin shells were broken up into fine nanoparticles by applying ultrasonic energy.



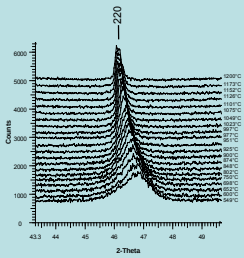
YSZ substrates were coated with LSM particles by spin coating a water based dispersion.

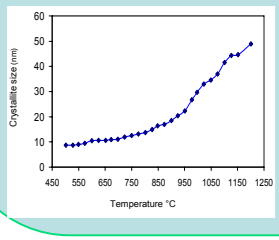
The dispersion was stabilized by charging the particles' surface via changing the pH value.

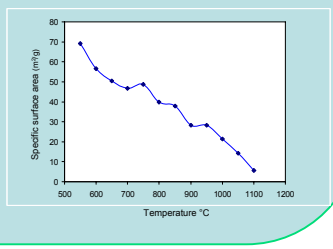


Thermal stability of nanocrystalline LSM powder

In-situ X-Ray diffraction of as prepared nanocrystalline LSM was carried out. The crystallite sizes at various temperatures were estimated from X-Ray line broadening of the (220) peak using Scherrer's formula. The specific surface areas after heat treatments at various temperatures for 1hr were obtained by the Brunauer-Emmett-Teller (BET) nitrogen adsorption technique. The results reveal the thermal and morphological stability below 850°C which is the highest working temperature in SOFC applications.

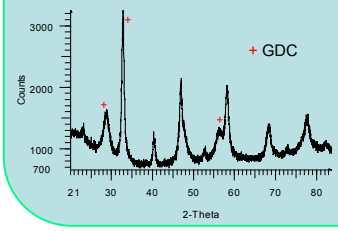


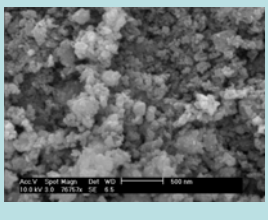




Synthesis of Nanocomposite LSM – GDC powder

Nanocomposite LSM-Gadolinium-doped Ceria (GDC) was synthesized via spray pyrolysis of the stabilized dispersion containing LSM nanoparticles and GDC precursor. The powder morphology consists of LSM particles coated by GDC nanoparticles, which provides a large TPB area.





Conclusions and outlook:

- Spray pyrolysis is a suitable method for the synthesis of LSM powder with fine microstructure. Below 850°C the powder is thermally and morphological stable and the thin film retains its porous structure.
- In future the electrochemical properties of LSM and composite cathode thin films will be investigated

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