MICROCELLULAR CORDIERITE CERAMICS TO ADDRESS ENVIRONMENTAL ASPECTS OF ENERGY STORAGE MATERIALS

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Introduction

The properties of final cordierite ceramics depend on the nature of used precursors, their molar ratio, on the presence of impurities or additives and on the processing conditions. As sources of aluminum, silicon and magnesium can be used a lot of different starting materials including a mixtures of individual oxides MgO, Al_2O_3 and SiO_2, or mixtures of natural raw materials such as kaolinite, talc, vermiculite, gibbsite, magnesite, diatomite, feldspar, quartz, fly ash, various clays or other minerals. Solid-state reactions represent the most conventional method for synthesizing of cordierite ceramics. Another way how to prepare the cordierite ceramic with closed porosity is using of pore formers or using of foaming method.

The focus of this work was to produce and characterize cordierite ceramics with different porosity with possible application in energy storage (e.g. as separator or solid electrolyte).

Experimental

The composition of pre-ceramic mixtures for all type of cordierite ceramics: **Kaolinite** (20 wt%), **Talc** (30 wt%), **Vermiculite** (30 wt%) and **Al_2O_3** (20 wt%).

Raw vermiculite (V) was used as precursore for ceramics **COR** and **COR_HP** while organovermiculite (VDODA) was used for **COR_VDODA** and **COR_VDODA_HP**. VDODA was prepared using the melt-intercalation of dodecylamine (DODA) to V at 60°C for 24 h. Hydrogen peroxide (HP) was used as a foaming agent. The pre-ceramic mixtures were homogenized by milling and sintered in crucibles in the furnace at 1300 °C for 1 h. Structural characterization of the ceramics was performed using the X-ray fluorescence analysis (XRF), the X-ray powder diffraction (XRD) analysis, Scanning electron microscopy (SEM) and porosity measurement.

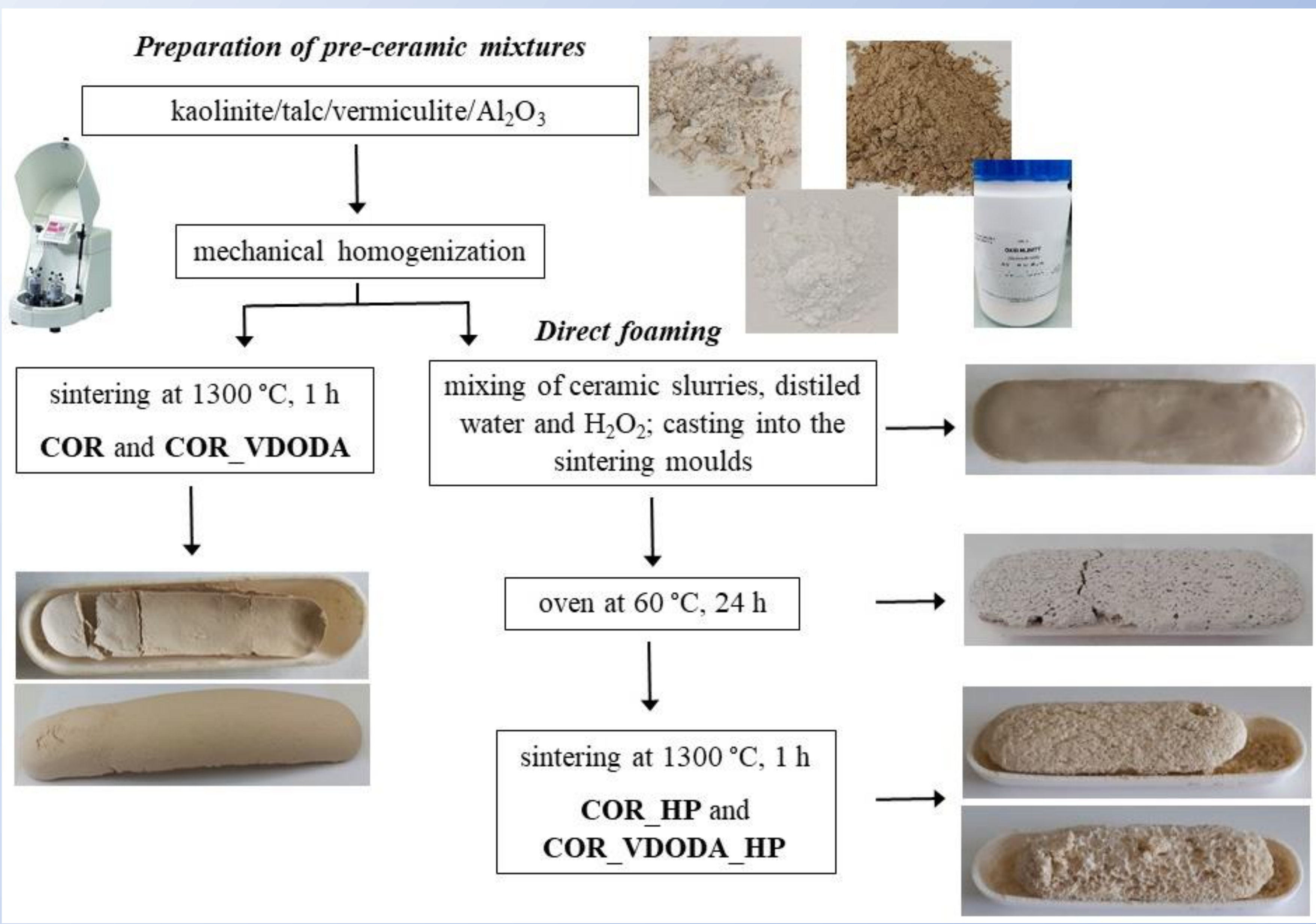


Fig. 1. Flowchart of the preparation steps of ceramic samples.

Characterization of cordierite ceramics

Tab. 1 Chemical composition of sintered ceramic samples evaluated with XRFS.

	SiO_2	Al_2O_3	MgO	Fe_2O_3	CaO	K_2O
	wt.%					
COR	42.30	33.60	16.33	3.95	2.01	0.80
COR_HP	44.20	34.00	13.65	3.90	2.23	0.88
COR_VDODA	44.05	34.85	14.10	3.49	1.92	0.78
COR_VDODA_HP	42.60	34.55	16.25	3.26	1.81	0.74

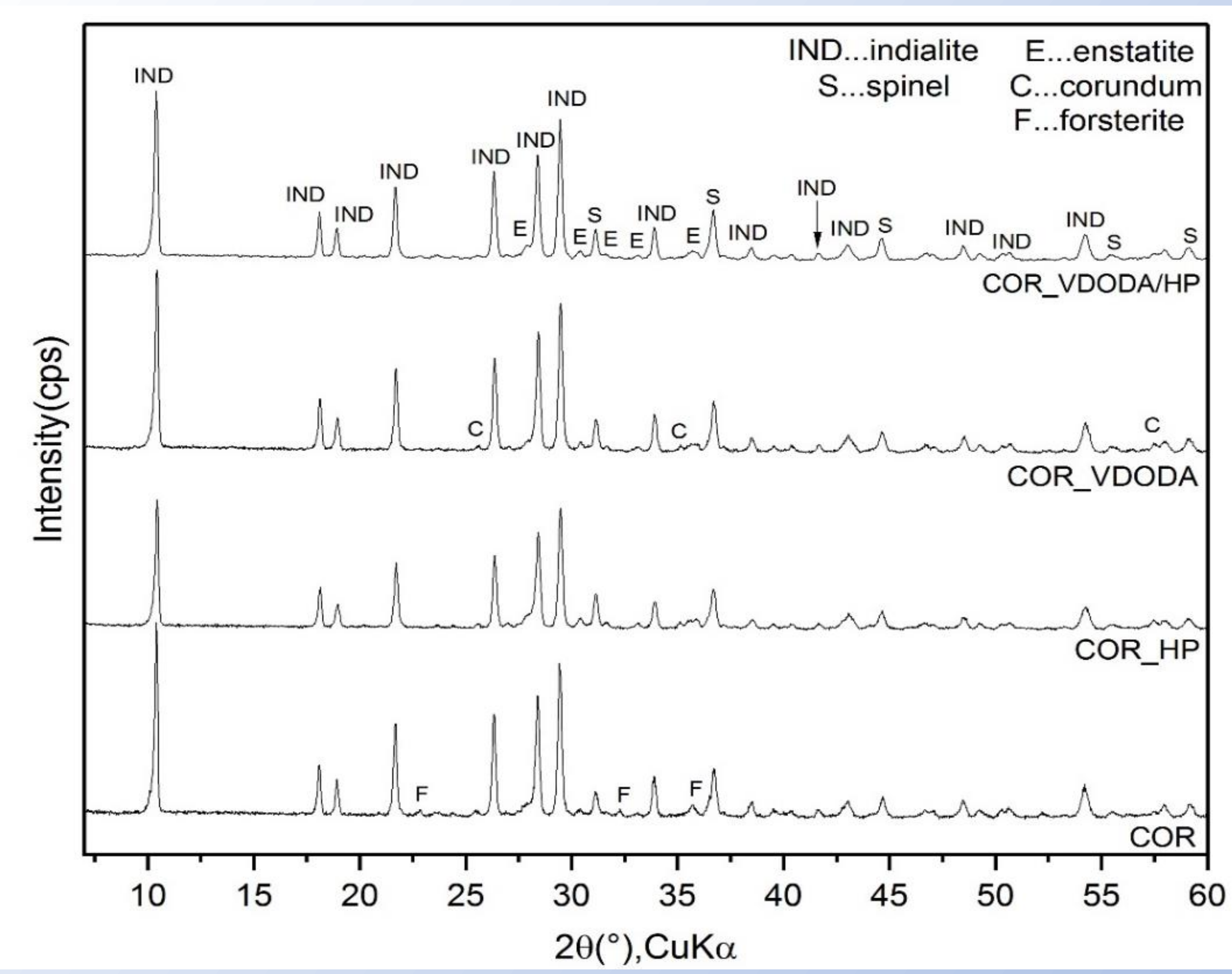


Fig. 2. Phase composition of sintered ceramic samples.

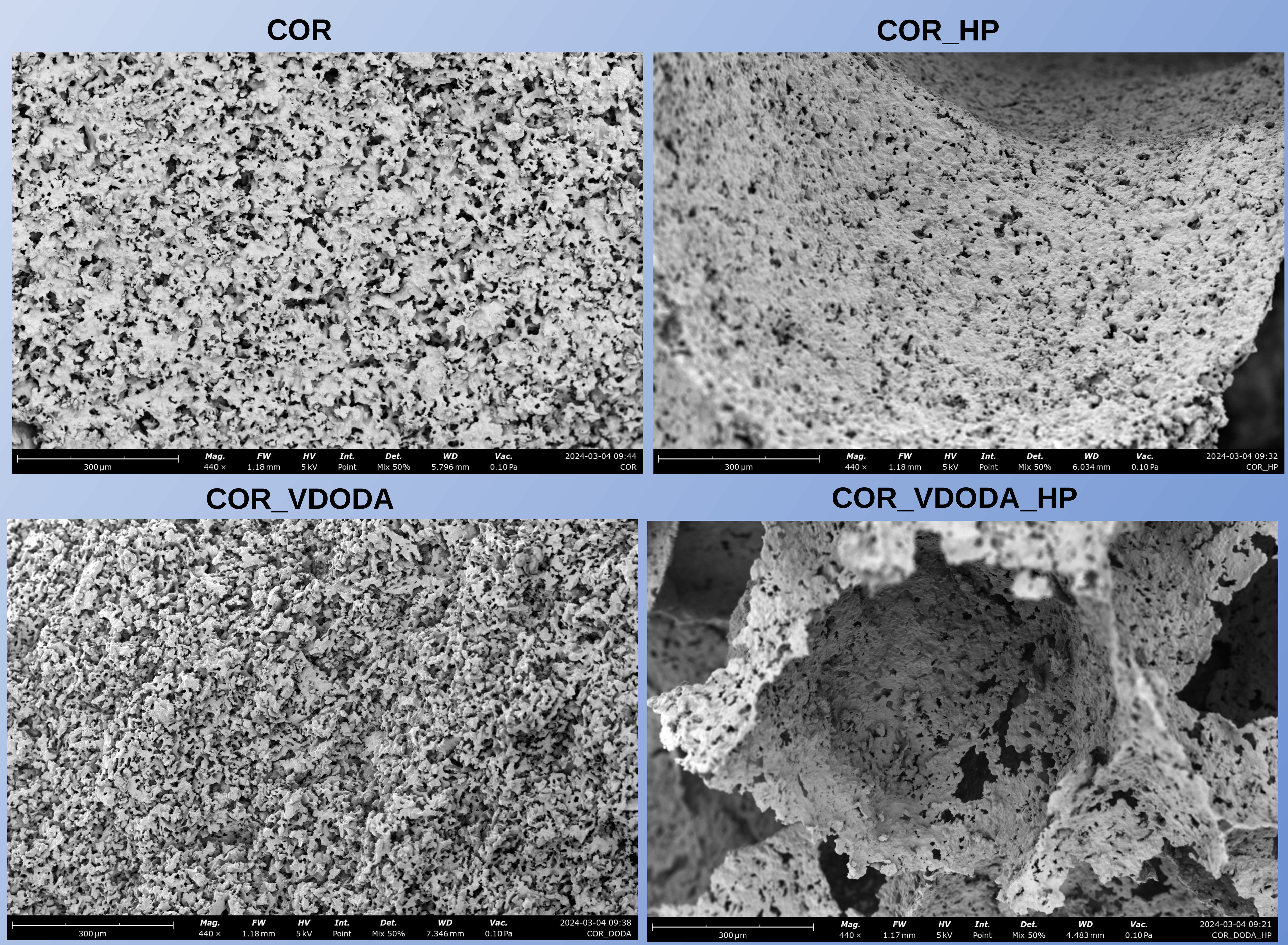
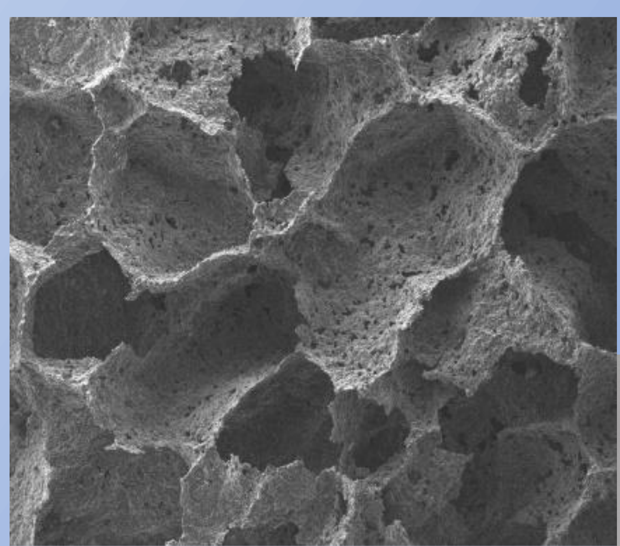


Fig. 3 SEM images of morphology variation of the cordierite ceramics.



Tab. 2. The values of true and apparent density and porosity obtained from helium gas pycnometry.

	True density	Apparent density	Porosity
	g/cm^3	g/cm^3	%
COR	2.789	0.948	66.02
COR_HP	2.767	1.071	61.30
COR_VDODA	2.860	0.107	96.26
COR_VDODA_HP	3.055	0.100	96.70

Conclusions

- Utilization of low-cost, natural raw materials sustainability and safety of the materials is reached.
- Simple foaming agent H_2O_2 was used to prepare a porous cordierite ceramics as suitable component for separators membrane or solid electrolytes in batteries
- In the second step, porous ceramics can be then blended with polymer, metal particles or carbon materials for further applications in batteries.

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