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Cordierite-based ceramic for high-temperature application: Development and characterization

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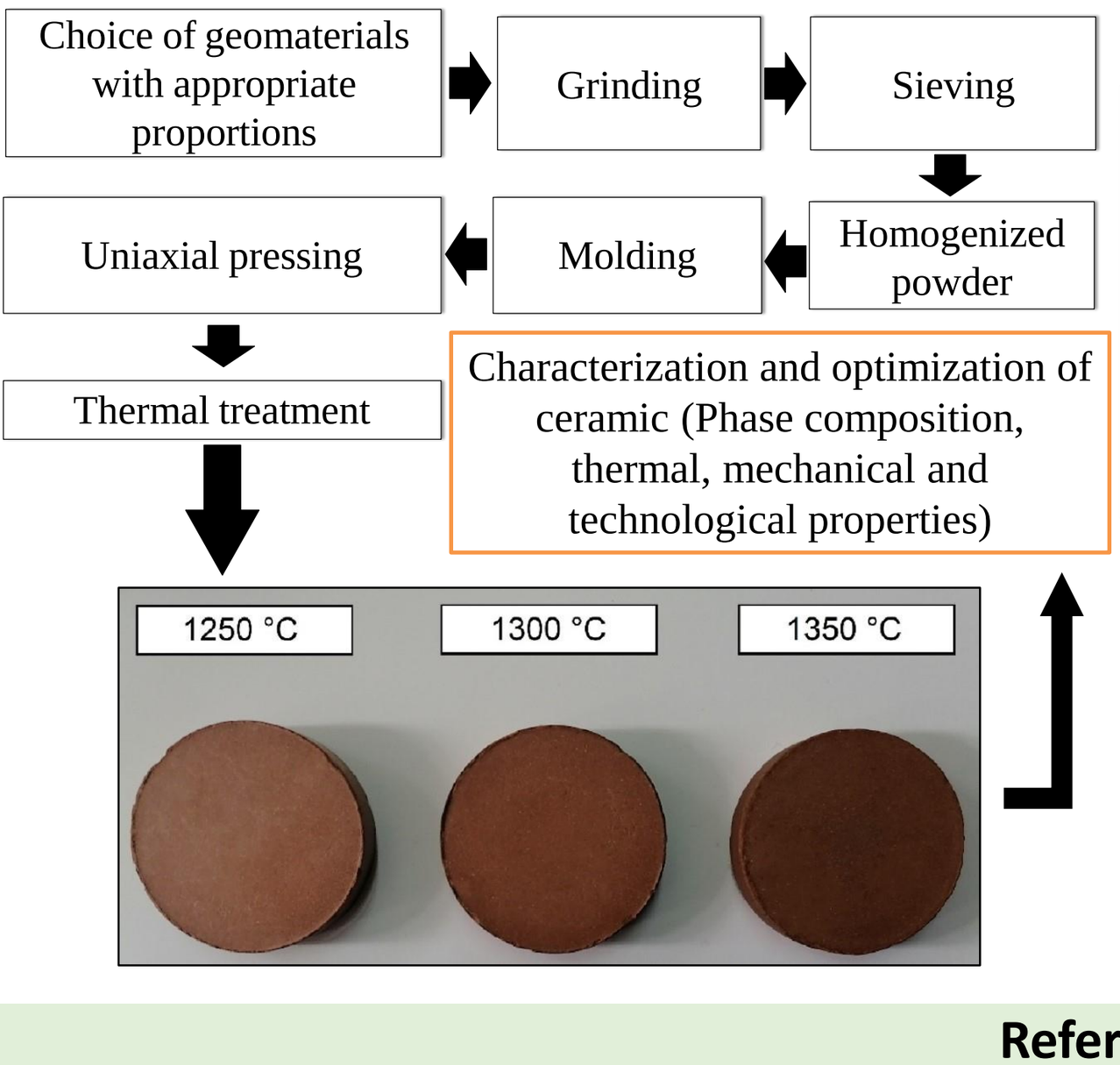
Introduction

Cordierite ($Al_3Mg_2AlSi_5O_{18}$) represents one of the refractory materials used for lining furnaces, ladles, glass tank controllers and secondary refining vessels for ferrous and non-ferrous metallurgy, due to its high refractoriness, thermal shock resistance, high chemical and thermal stability, high refractoriness and high mechanical strength. Cordierite ceramics have been fabricated at low temperatures by the sol-gel method using Si and Al alkoxides, using very expensive materials and complicated production processes. Thus, a solid-state reaction route is proposed as an alternative and economical way to produce cordierite ceramics. In this work, cordierite ceramics were fabricated from Moroccan halloysite and peridotite using a simple and inexpensive fabrication method. Furthermore, we focus on the valorization of abundant and inexpensive Moroccan geomaterials for such applications.

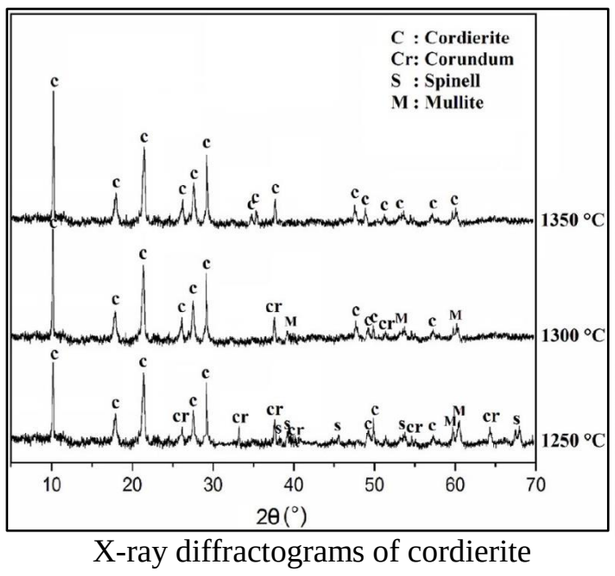
Methods



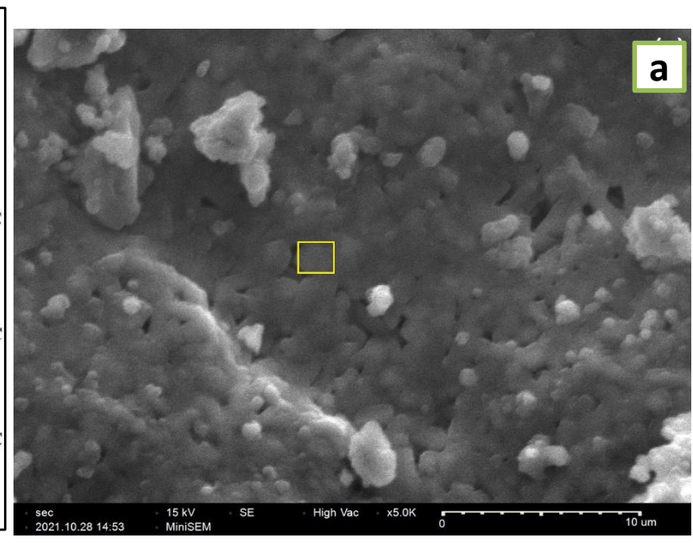
Results

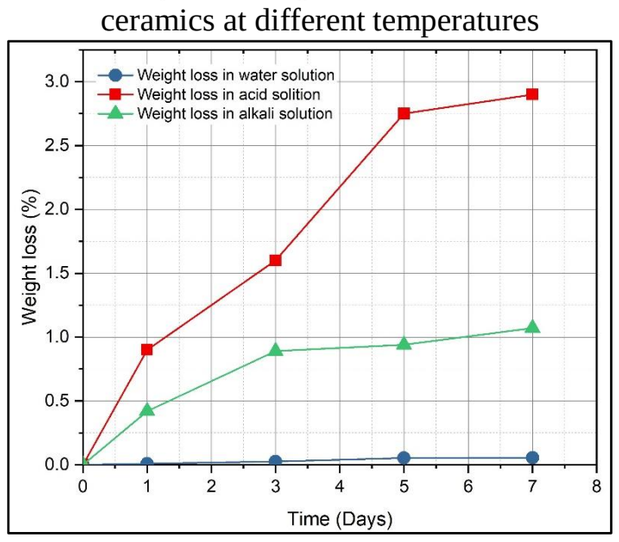
Thermal and technological properties of the prepared ceramic specimens

Sintering temperature (°C)	Thermal expansion coefficient (400–1200 °C)		Technological properties of the cordierite ceramics fired up to 1350 °C				Thermal properties of the cordierite ceramic fired to 1350 °C	
	α_{L1} (10^{-6}/°C)	α_{V1} (10^{-6}/°C)	Porosity (%)	Density (g/cm^3)	Linear shrinkage (%)	Diametral compression (MPa)		
1250	3.05	9.15	4.56	2.45	6.51	20.35	Refractoriness (°C)	1423
1300	2.78	8.34	3.24	2.67	8.01	23.07	Cyclic thermal shock (Cycles)	34
1350	2.18	6.54	3.11	2.78	10.23	27.60	Thermal stress (MPa)	19.38

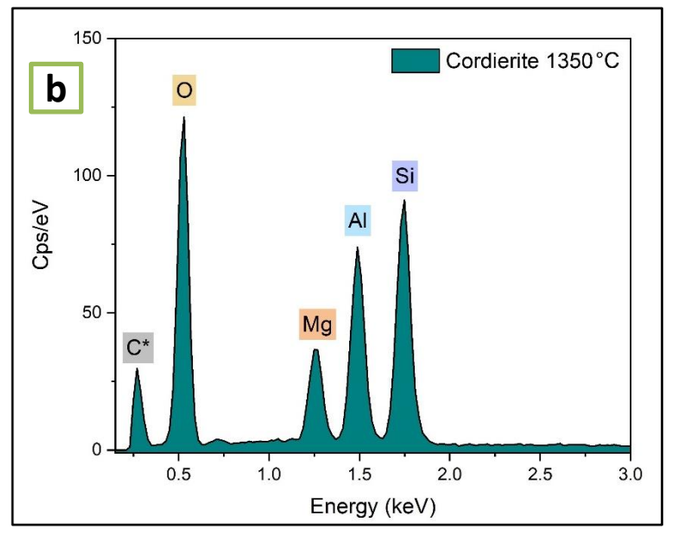


X-ray diffractograms of cordierite ceramics at different temperatures





Weight loss versus time of cordierite ceramic specimen (Temperature: 1350 °C, pH = 1.3, pH = 7.1 and pH = 13.0)



a, SEM Micrographs of cordierite, b. EDS analysis of the yellow marked area

Conclusion

This study has been conducted to evaluate the potential use of Moroccan halloysite and peridotite as raw materials for refractory ceramic industry. Cordierite-based ceramics with enhanced technological, thermal and chemical properties were achieved at a sintering temperature of 1350 °C. The composition of the phase is highly in cordierite. This ceramic was able to resist thermal stress of 19.38 MPa, a cyclic thermal shock of 34 cycles and refractoriness of 1423 °C.

References

1 A. Harrati, Y. Arkame, A. Manni, A. El Haddar, B. Achiou, A. El Bouari, I.-E. El Amrani El Hassani, A. Sdiri, C. Sadik, Cordierite-based refractory ceramics from natural halloysite and peridotite: Insights on technological properties, J. Indian Chem. Soc. 99 (2022) 100496.

2 O.A. Al-Harbi, C. Özgür, M.M. Khan, Fabrication and characterization of single phase cordierite honeycomb monolith with porous wall from natural raw materials as catalyst support, Ceram. Int. 41 (2015) 3526–3532.

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