268

$Bi_6Te_{2-x}R_xO_{13}$ (R=Ti, Si, Ce) Systems: A Investigation for Fuel Cell Applications

K. D. Ferreira[1], G. Gasparatto[2], G.P. Viajante[1] and J.F. Carvalho[2]
[1]Instituto Federal de Goiás; [2]Universidade Federal de Goiás
katiuscia.ferreira@ifg.edu.br

INTRODUCTION

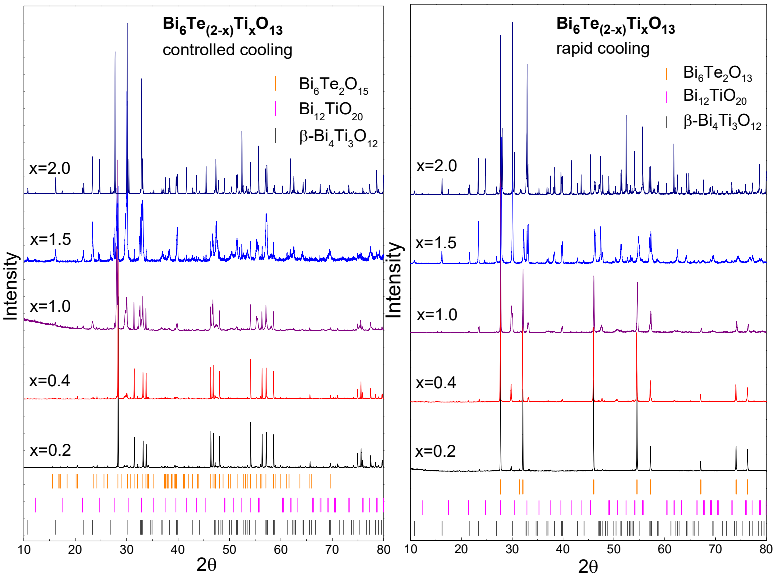
- Among the renewable energy sources , fuel cells stand out
- Among the different types are the solid oxide fuel cell (SOFC).
- These devices use oxygen ion conducting oxide materials
- The challenge: the study and development of SOFC able of operating at lower temperatures (400-700° C).
- High conductivity values is observed in determined crystalline structures as cubic phase of δ-Bi_2O_3 (fluorite structure)
- $3Bi_2O_3$:$2TeO_2$ present two phases: $Bi_6Te_2O_{15}$ orthorhombic one and the high temperature cubic phase $Bi_6Te_2O_{13}$ [1,2,3]
- Challenge: obtaining the cubic phase at room temperature.
- Partial replacement of the Te ions in the $Bi_6Te_{2-x}R_xO_{13}$ (R=Ti, Si and Ce) was done in order to stabilize the cubic phase
- Ti, Si and Ce ions have been chosen because present the same oxidation state (IV) and ionic radius close to Te ions.

MATERIALS and METHODS

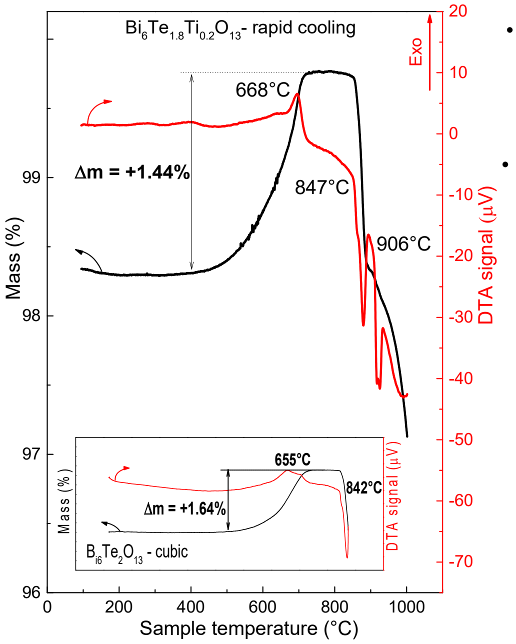
- Solid-state reaction: Heat treatment under air at 750° C and 870° C for 24h using a horizontal tubular furnace.
- Cooling rate: Slow (2° C/min) and rapid (quenching)
- Characterization: XRD, TG/DTA

RESULTS

- **$Bi_6Te_{2-x}Ti_xO_{13}$**

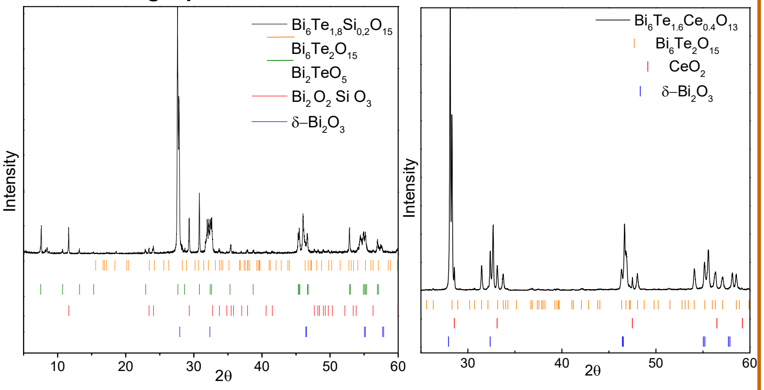


- **First heat treatment: formed a mixture of the $Bi_6Te_2O_{15}$ (orthorhombic), $Bi_{12}TiO_{20}$ (Sillenite) and β-$Bi_4Ti_3O_{12}$ (Perovskita) compositions.**
- **Second heat treatment: presented the same mixture, with the exception of the cubic phase of composition $Bi_6Te_2O_{13}$ that was formed instead of the orthorhombic phase**



- **TG/DTA analyses show that cubic phase in mixture is not stable**
- **The widest profile of the third peak indicate the overlap of thermal events related to the melting of the different components in the mixture**

- **$Bi_6Te_{2-x}Si_xO_{13}$ and $Bi_6Te_{2-x}Ce_xO_{13}$**
- **Replacement of Te by Si and Ce do not lead to the formation of a single phase but a mixture**



CONCLUSIONS

- The attempt to stabilize the cubic phase of the $Bi_6Te_2O_{13}$ system at room temperature through the insertion of Ti, Si and Ce ions in $Bi_6Te_{2-x}R_xO_{13}$ (R = Ti, Si and Ce) compositions, resulted in mixtures
- The formation of multiphase systems did not allow conductivity measures.
- Studies with others cations to replace Bi or Te are in progress intending to stabilize the cubic phase in lower temperatures to fuel cells applications.

REFERENCES

[1] T. Kikuchi, Y. Kitami, M. Yokoyama. “Pseudo-binary system Bi2O3-TeO2 in air”. Journal of materials Science (1989). V.24, p.4275-4278.
[2] H. Sakai et al. “Investigation of a high-temperature phase of 3Bi203: 2TeO2 binary oxide”. Hyperfine Interactions (1994). V. 90, p. 401-405.
[3] K.D. Ferreira et al. “Phase stability and properties of Bi6Te2O13+δ (δ = 0 or 2)”. Physica B: Physics of Condensed Matter(2021). V. 605, 412780.

ACKNOWLEDGEMENT

FAPEG
CNPq
Crti
CAPES
LabMic
NUPEQUI
INSTITUTO FEDERAL Goiás