

# Tetragonal tungsten bronzes based on alkaline and rare earth elements: XRD, SEM, and dielectric properties for various applications

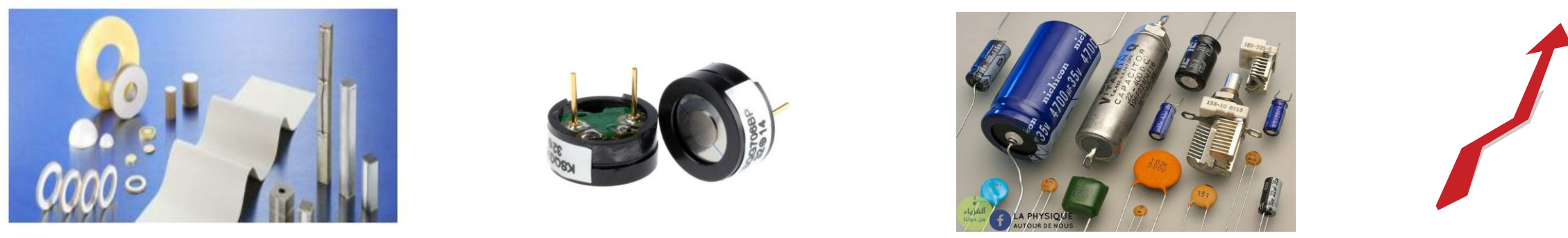
K. CHOURTI 1, H. KABDANI 1, F. CHAOU 2, I. JAFALI 1, E. AKICHOUH 1, A. BENDAHHOU 1, and M. ABOU-SALAMA 1

1 Laboratory of Molecular Chemistry, Materials and Environment, Faculty Multidisciplinary Nador, University Mohamed Premier, Morocco

2 Laboratory of Physical Chemistry of Materials, Faculty of Sciences, Chouaib Doukkali University, El Jadida, Morocco

## INTRODUCTION & AIM

TTB-structured materials are of significant interest in technology and have been extensively studied using various physical methods.

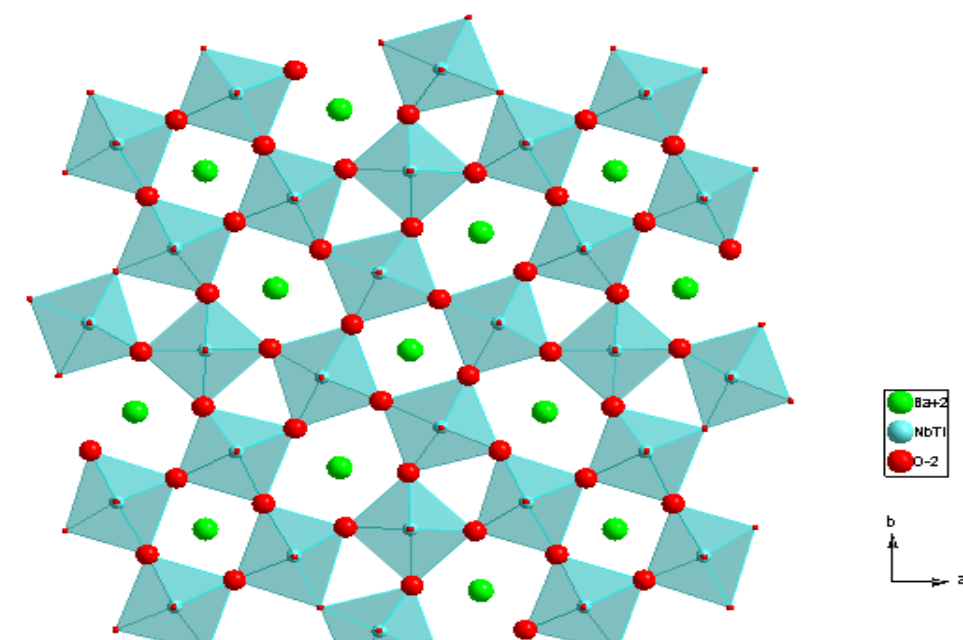


Electrical devices: transducers, actuators, capacitors, microwave telecommunication systems, and energy storage capacity.

Projection of the tetragonal bronze structure

$a=b \sim 12,5 \text{ \AA}$  et  $c \sim 4 \text{ \AA}$ .  $P4bm$ ,  $P4/mbm$  ...

- Pentagonal site (A2), CN-15
- Square site (A1), CN-12
- Triangle site (C), CN-9



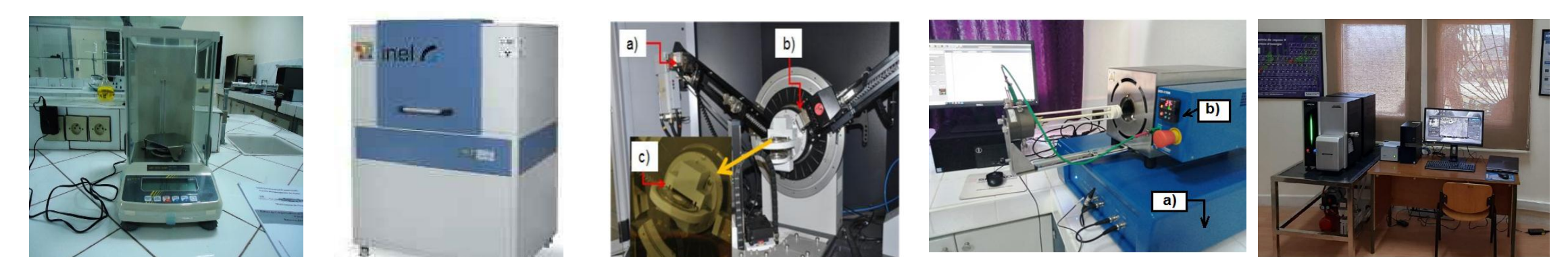
In this context, the study of solid solutions  $A_2(Sm_{1-x}RE_x)Ti_2Nb_3O_{15}$  ( $A = Sr, Ba; RE = Nd, Gd, La$ ) provides an ideal framework to examine the influence of rare-earth ionic radii on the TTB structure and its dielectric properties, offering key insights for the development of high-performance ceramics.

## METHOD

Synthesis



Characterization



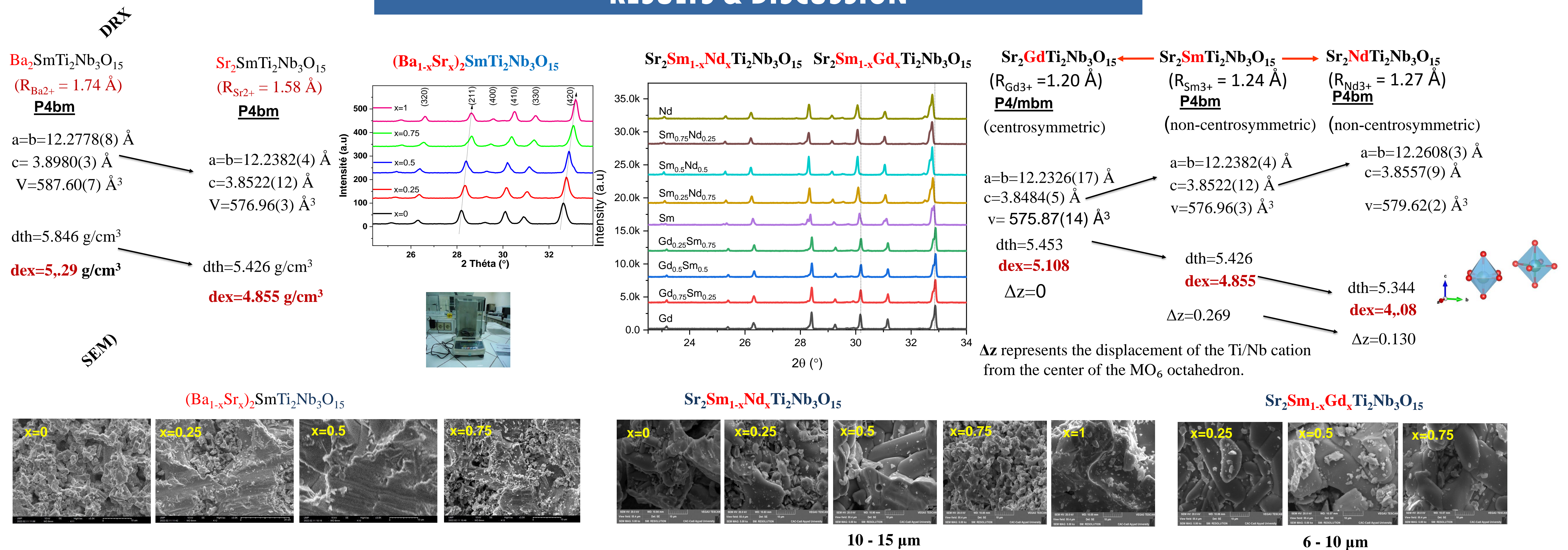
Density (KERN analytical balance)

DRX (Inel and bruker D8)

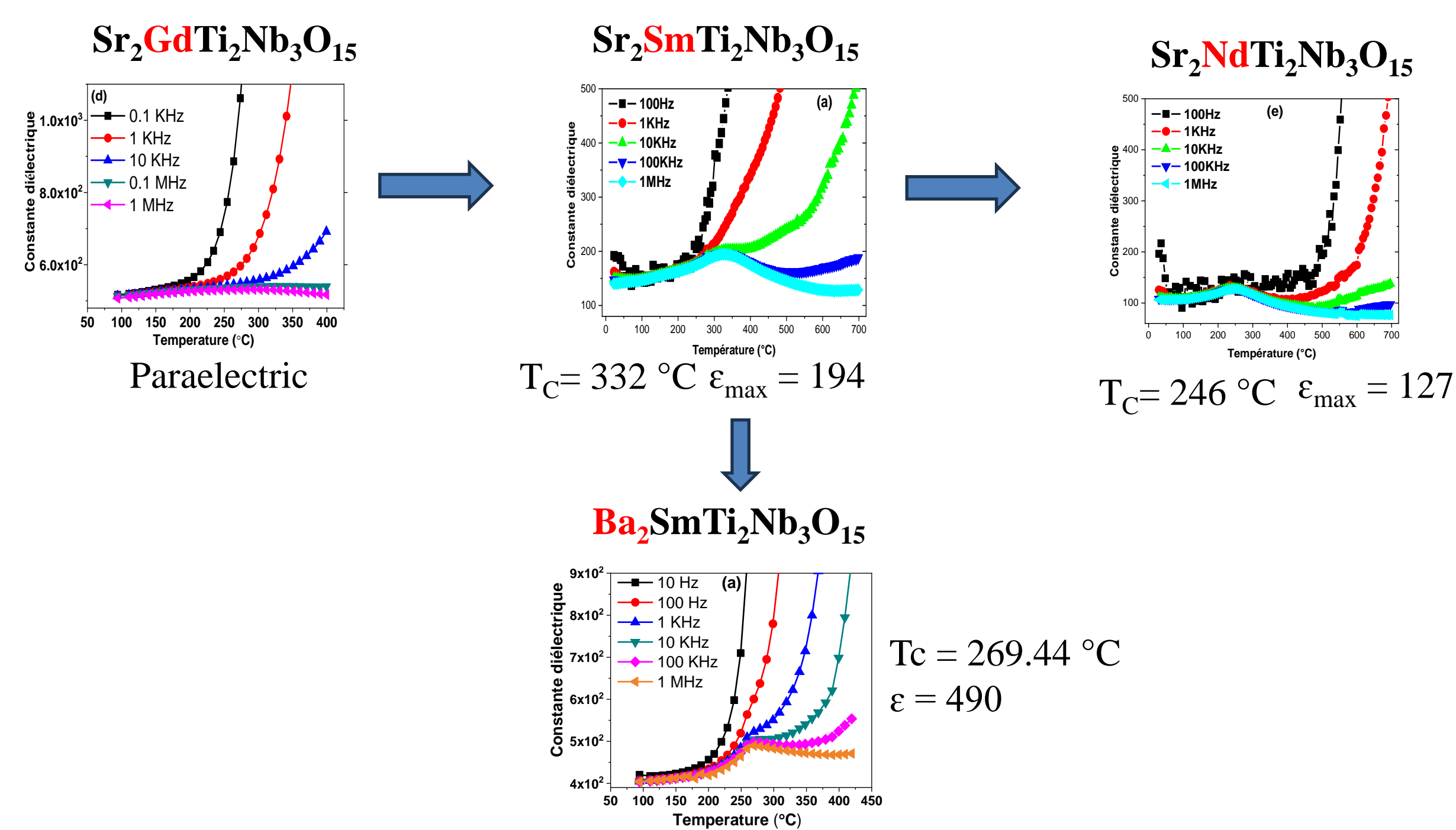
Dielectric measurements (HP 4194A and MTZ-35 impedance analyzer)

SEM and EDX

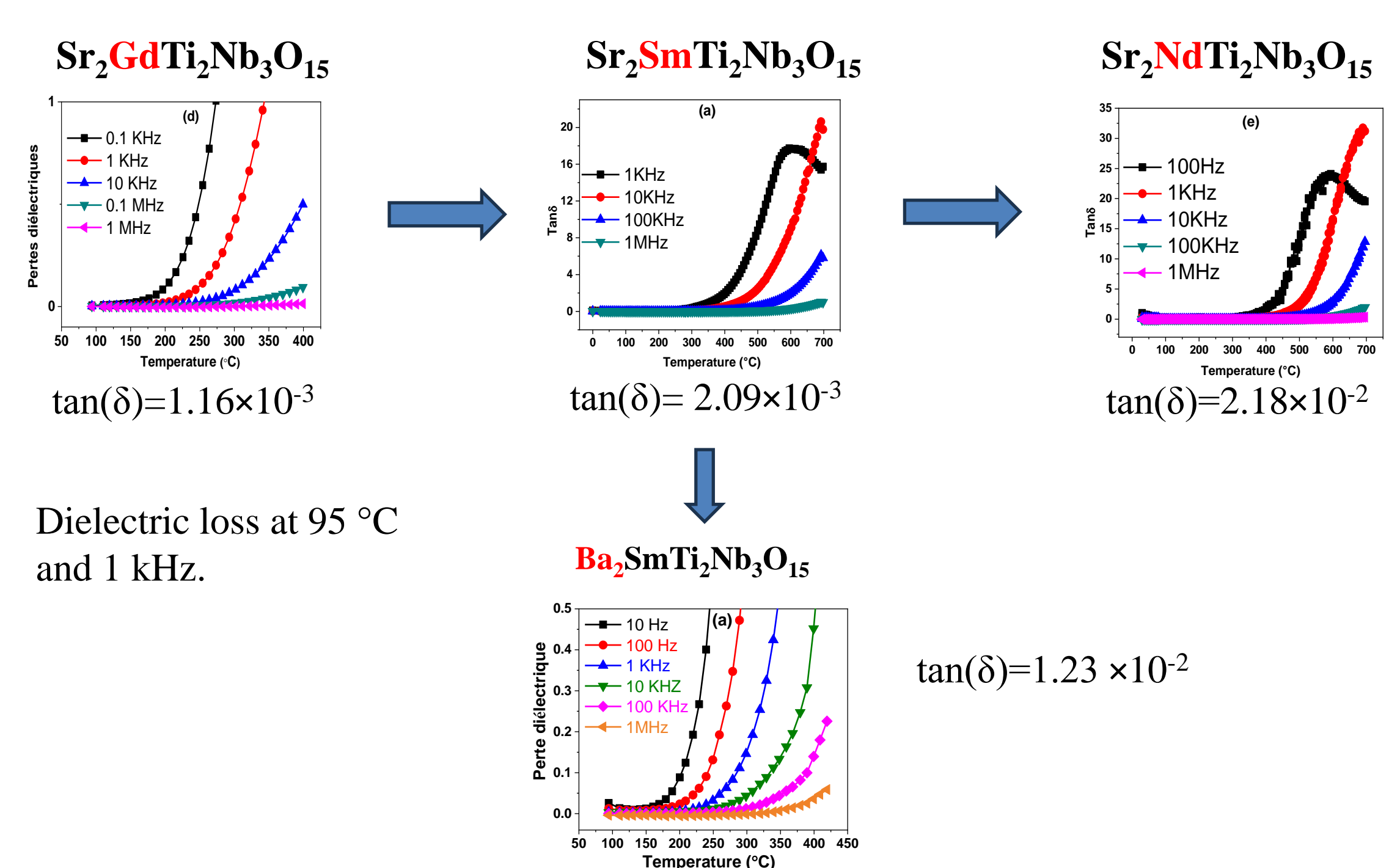
## RESULTS & DISCUSSION



Dielectric constant



Dielectric loss



## CONCLUSIONS

- The compounds  $A_2(Sm_{1-x}RE_x)Ti_2Nb_3O_{15}$  ( $A = Sr, Ba; RE = Nd, Sm, Gd$ ) were synthesized via solid-state reaction.
- Substitution in TTB compounds by smaller ionic radius ions leads to a contraction of the crystal lattice.
- All the compounds crystallize in the tetragonal system with the space group  $P4bm$ , except the Gd-based compound, which crystallizes in  $P4/mbm$ .
- Dielectric measurements show that all the compounds are ferroelectric, except the Gd-based compound.
- $Ba_2SmTi_2Nb_3O_{15}$ : better for high permittivity applications ( $\epsilon_r = 490$ )
- $Sr_2SmTi_2Nb_3O_{15}$ : better for high-temperature ferroelectric applications ( $T_C = 332 \text{ }^\circ C$ ).
- The dielectric loss is low for the Gd-based compound. The dielectric loss value is in the order of  $10^{-2}$  to  $10^{-3}$ .

## FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

Future work :

TTB ceramics are promising materials for advanced dielectric, ferroelectric, and energy storage applications due to their high permittivity and low dielectric losses.

Acknowledgement :

Laboratoire de Chimie Moléculaire, Matériaux et Environnement, Faculté Multidisciplinaire de Nador.

The authors declare no conflicts of interest.