



Posibilitati de control al structurii si morfologiei nanoparticulelor de BaTiO_3

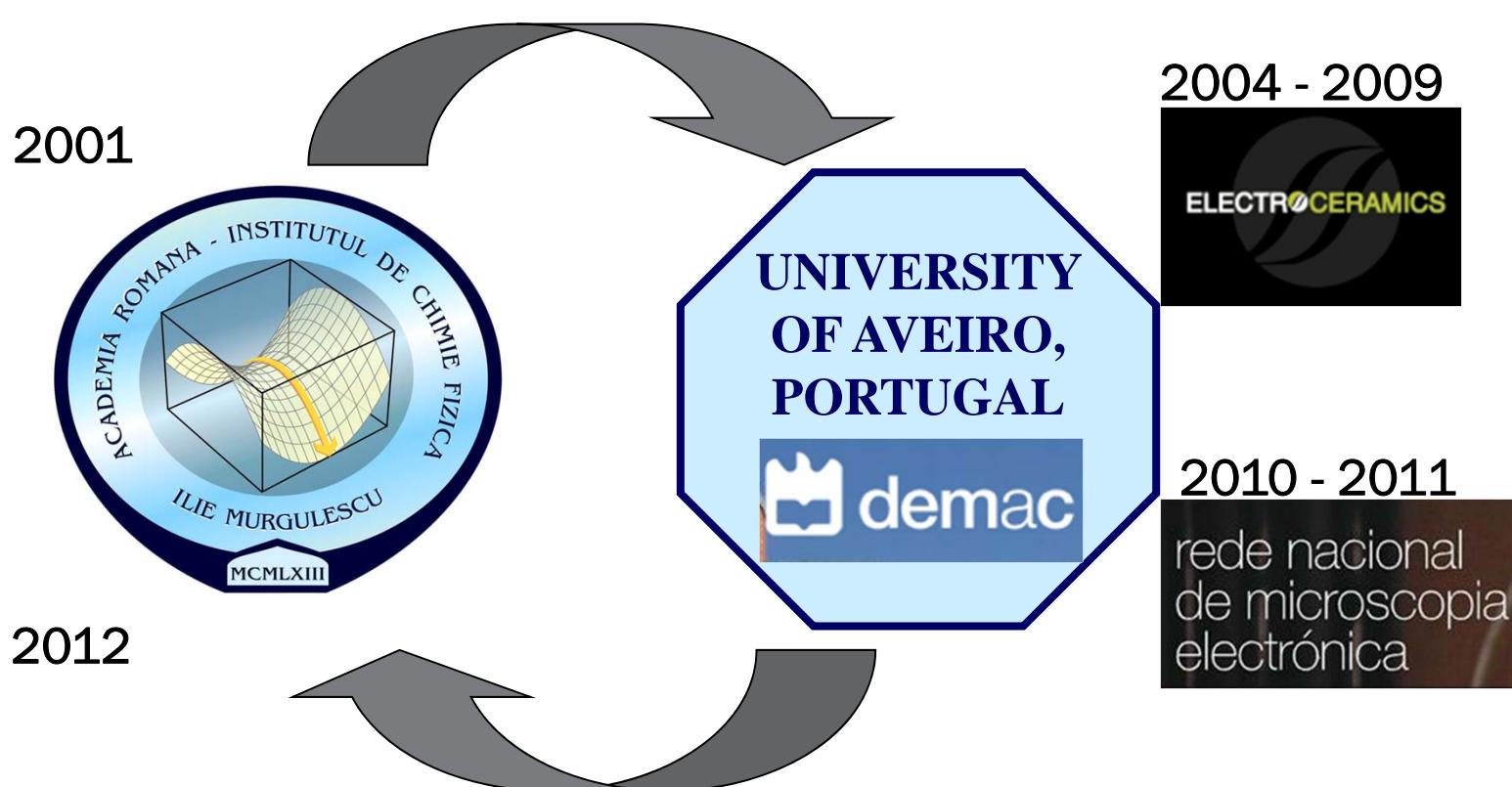
**Strategies for the structure and
morphology control of BaTiO_3
nanoparticles**





Florentina Maxim

Laboratorul de Termodinamica Chimica, Institutul de Chimie Fizica "Ilie Murgulescu" al Academiei Romane, Bucuresti





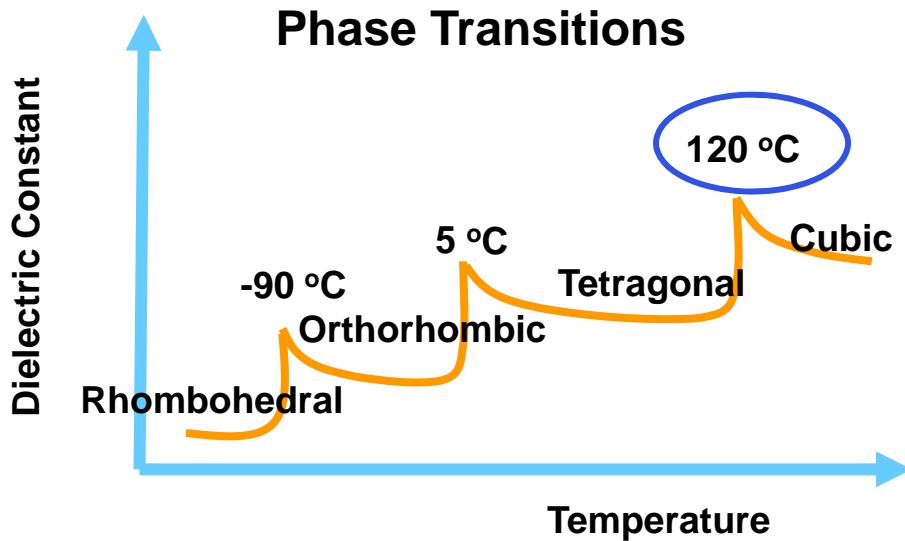
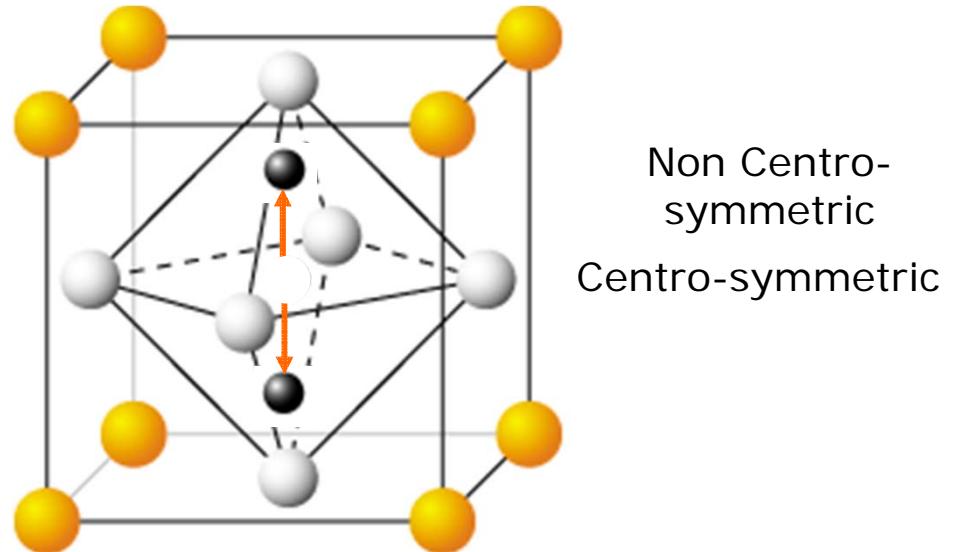
Outline

- State of the art
- Experimental & Results
- Main Contributions
- Lessons learned

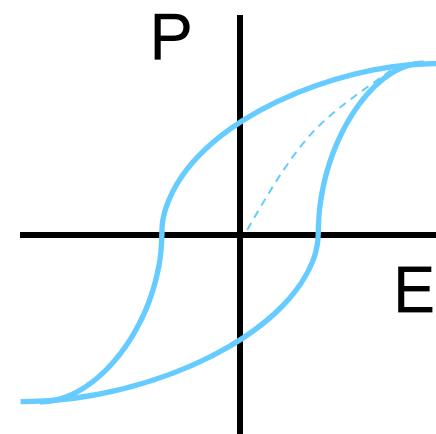


State of the art - BaTiO₃ Structure

- Ba - A site cation
- Oxygen
- Ti - B site cation



Spontaneous polarization

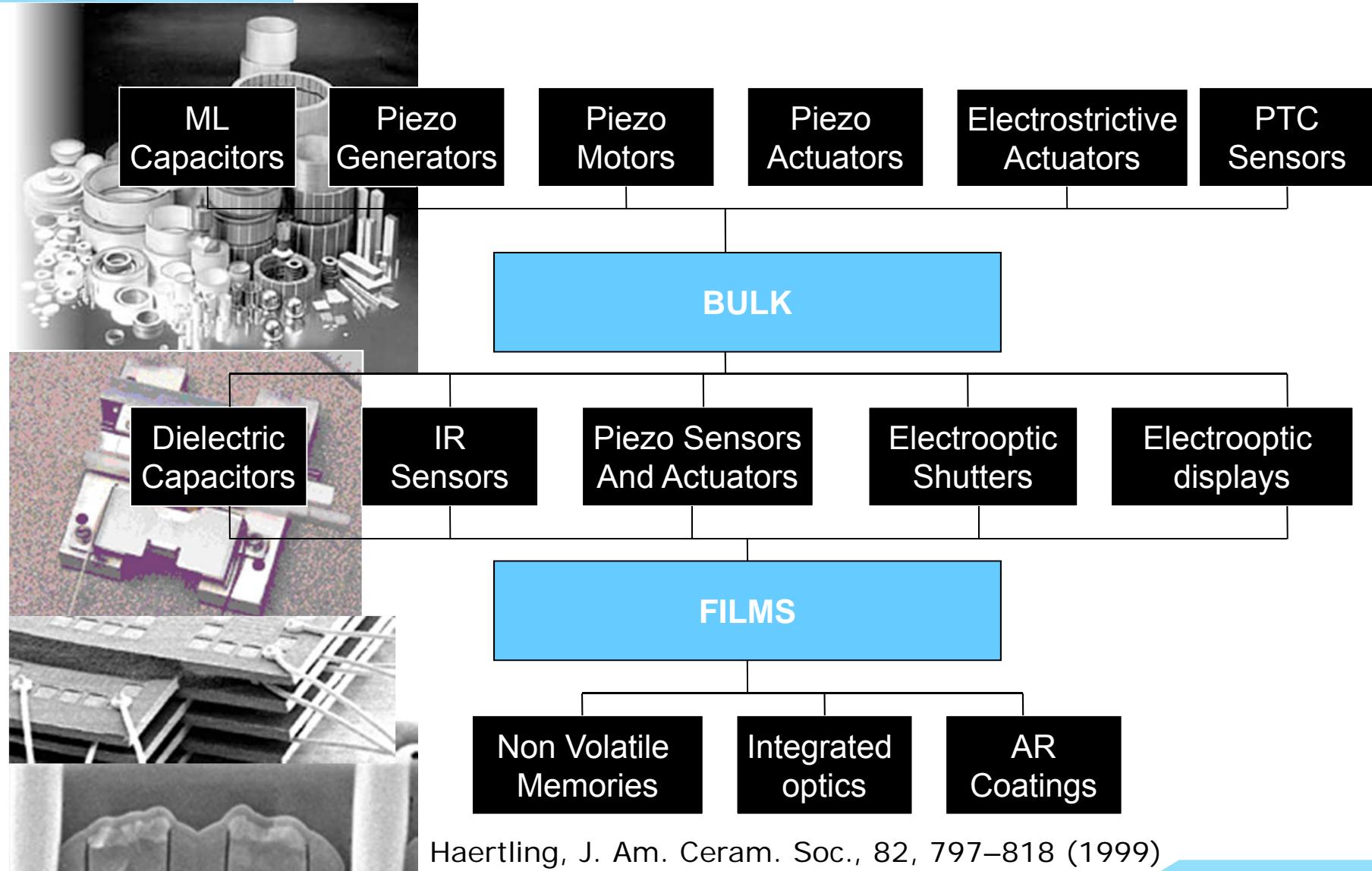


Switching ----- Ferroelectric





Ferroelectrics Applications



Haertling, J. Am. Ceram. Soc., 82, 797–818 (1999)





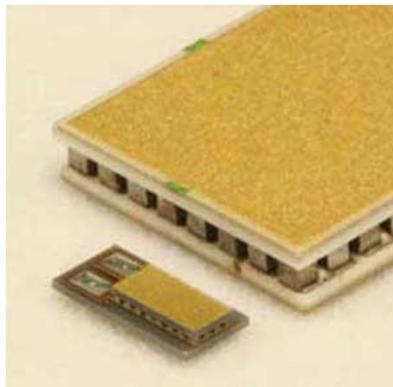
New demands

"Smaller, faster, cheaper, quicker is the mantra, as users seek to increase the level of functionality they have in all their devices."

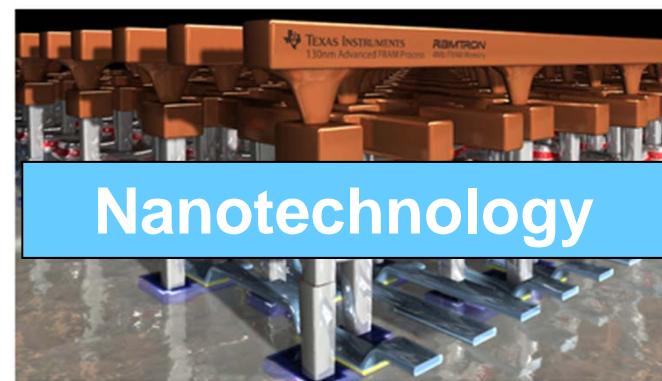
Dr. Paul A. Magill (2009)

Miniaturization electronic devices

**Micro-scale
thermoelectric cooler**



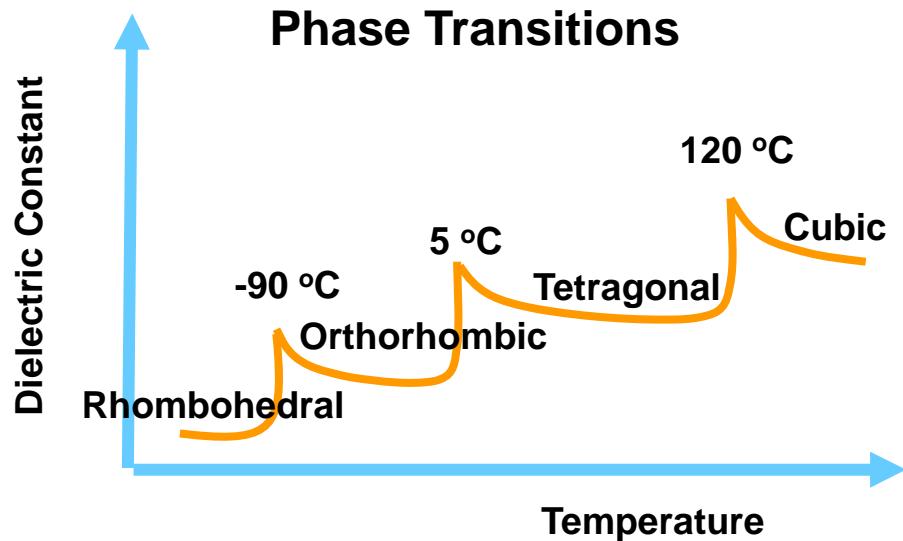
**The Smarter IC Memory
TI 130nm FeRAM**



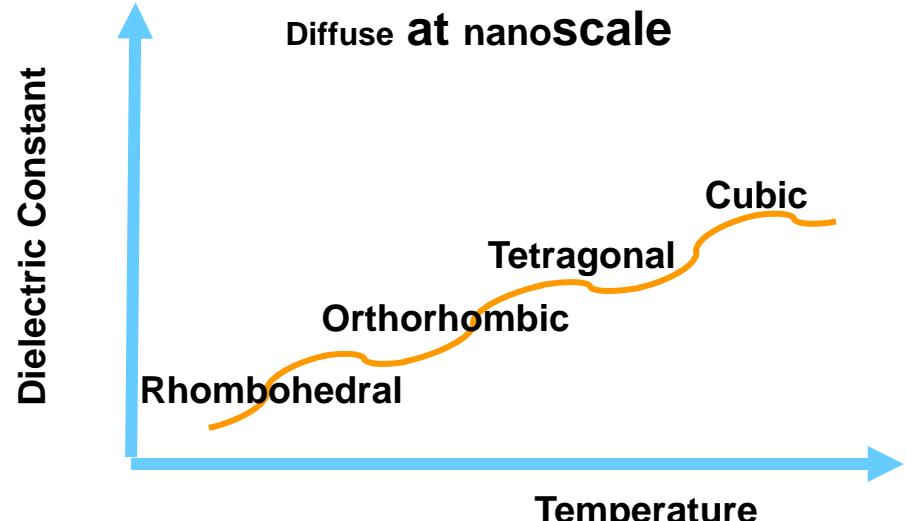
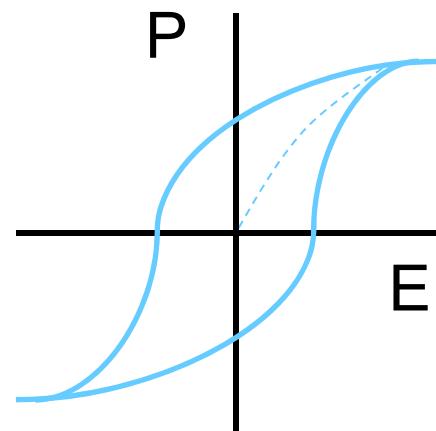
**The World's Smallest
Piezoelectric Motor**



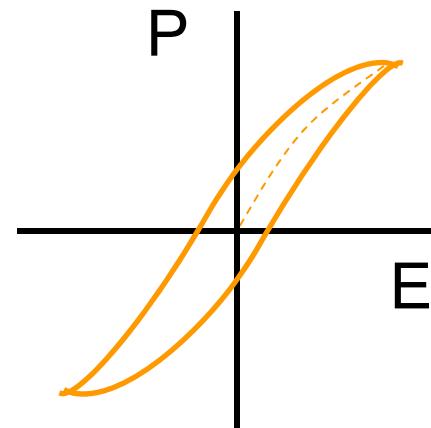
BaTiO₃ at nanoscale?



Spontaneous polarization



Decreasing at nanoscale

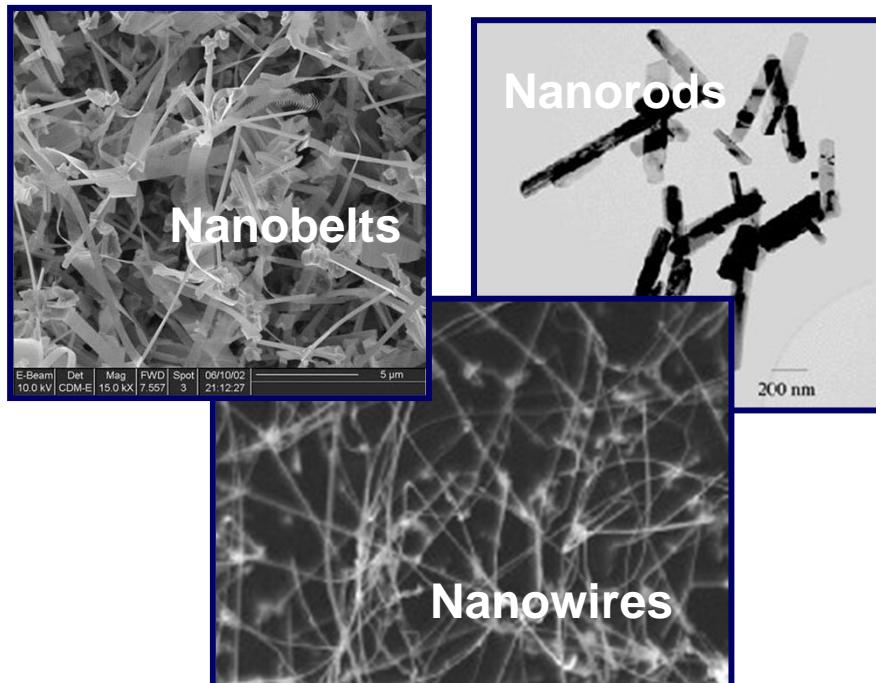




Anisotropic Ferroelectrics?

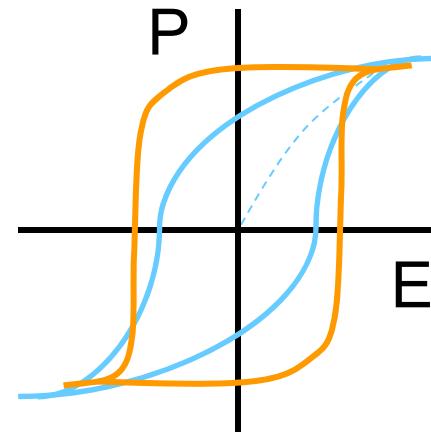
“Enhancement of ferroelectric properties
in anisotropic 1D nanoferroelectrics”

Morozovskaa et al, *Physica B: Condensed Matter.* (2007)



Spontaneous polarization

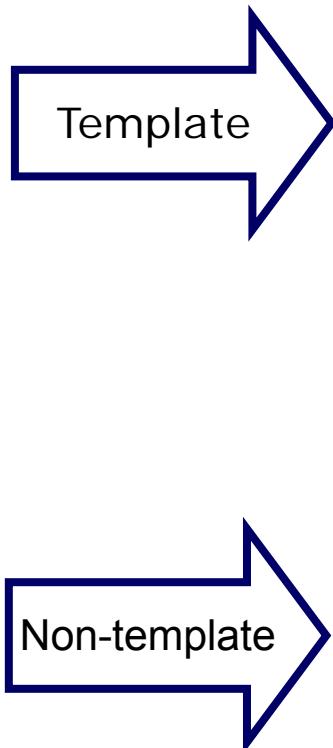
Increasing for 1D



For this is needed to study
the anisotropic growth

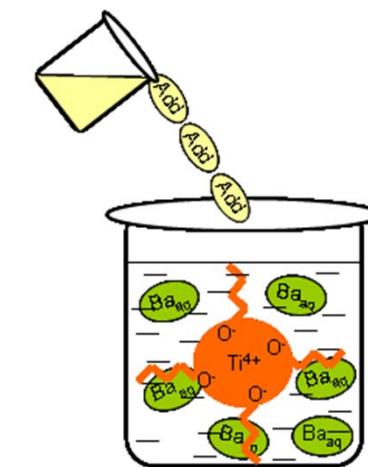
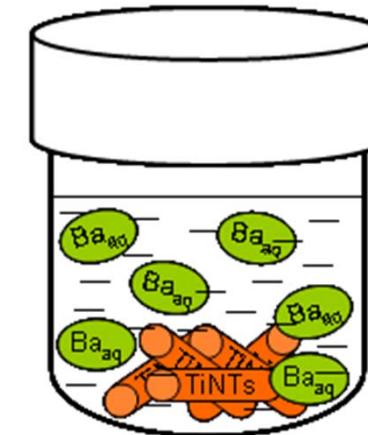


Hydrothermal synthesis



Chemical template using TiNTs

Additive assisted using Ti alkoxides



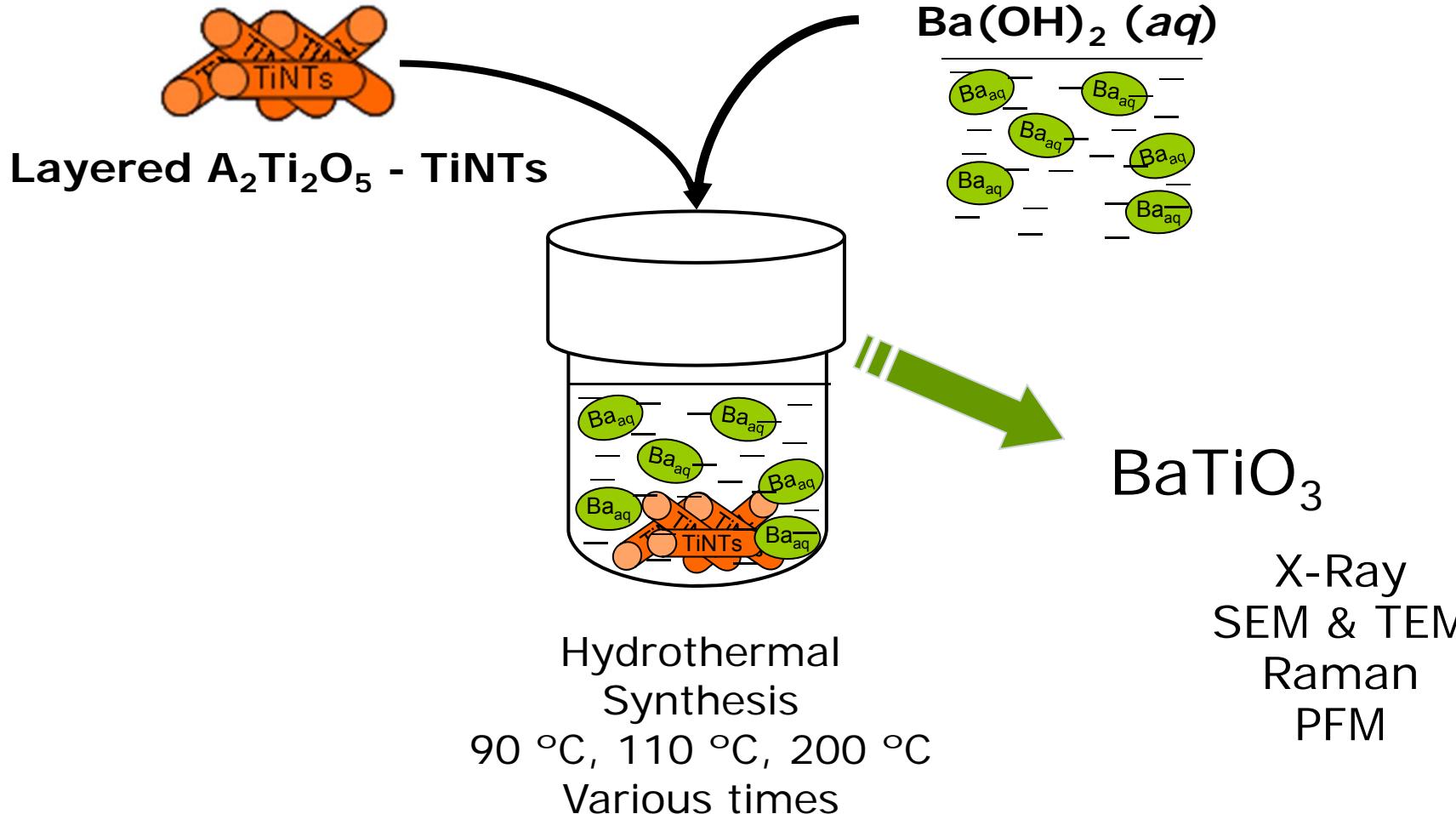


Template Strategy

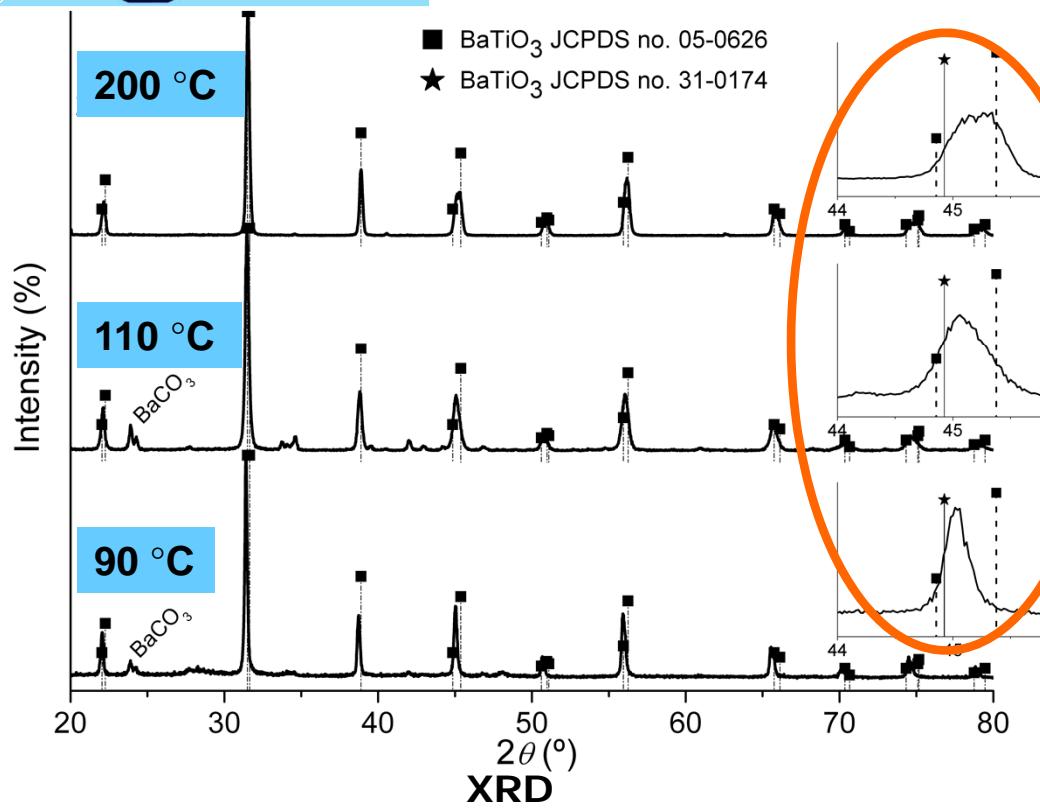




Chemical Template - Experimental

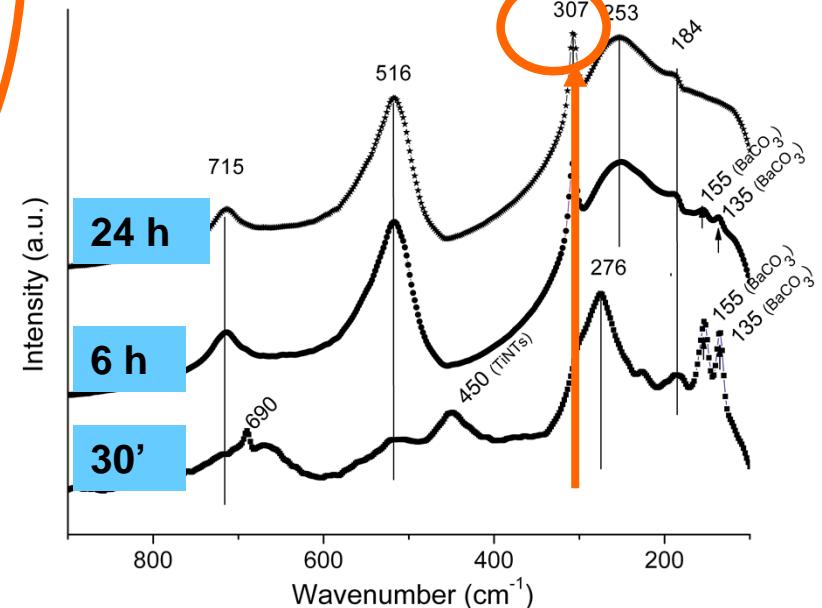


Structure – Temperature, Time



Gradual from
pseudo-cubic to
tetragonal

Raman



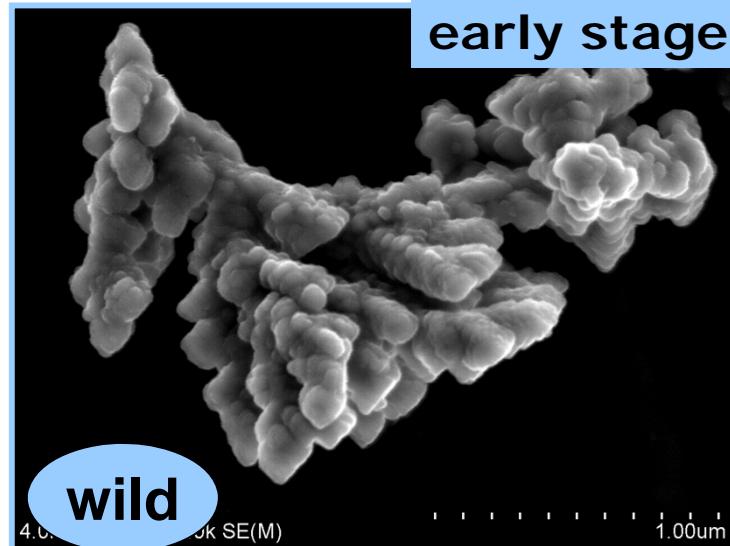
Maxim et al., *Crystal Growth & Design*, 2008.

Maxim et al., *Crystal Growth & Design*, 2011.

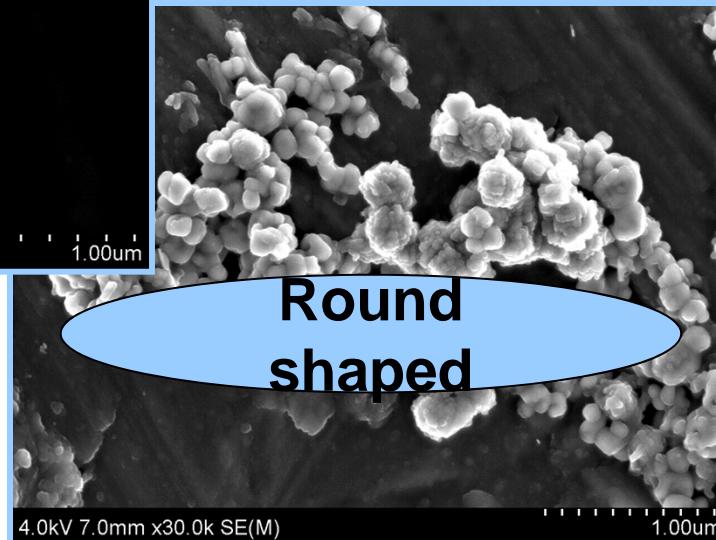
Maxim et al., *Processing and Application of Ceramics*, 2010.



Morphology – Temperature, Time

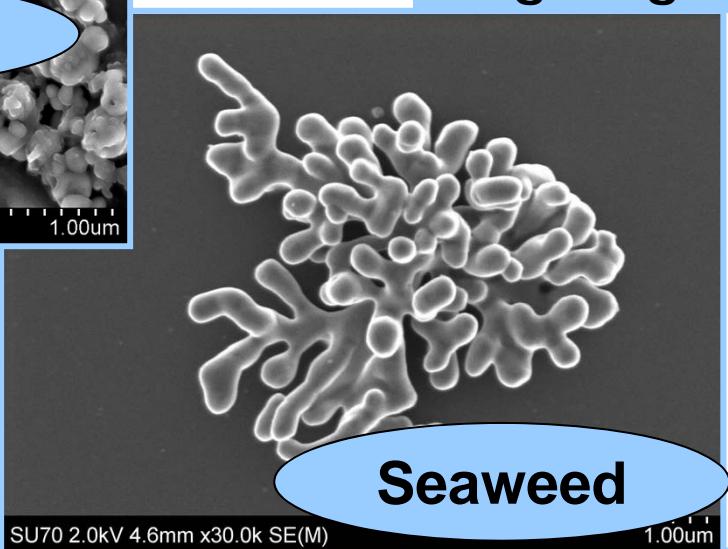


intermediate stage



SEM

long stage



Maxim et al., *Crystal Growth & Design*, 2008.

Maxim et al., *Crystal Growth & Design*, 2011.

Maxim et al., *Processing and Application of Ceramics*, 2010.



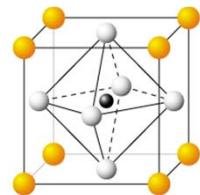


We proved...

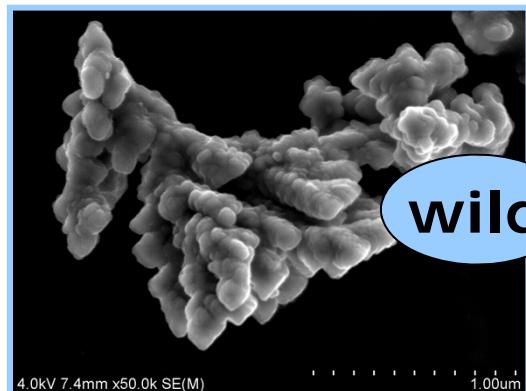
Maxim et al., *Crystal Growth & Design*, 2008.

Maxim et al., *Processing and Application of Ceramics*, 2010.

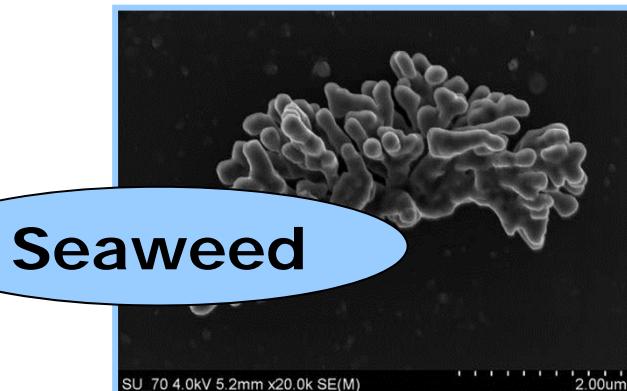
Maxim et al., *Crystal Growth & Design*, 2011.



Cubic BT

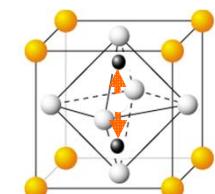


At high temperature,
high time



At low temperature,
low time

Tetragonal BT





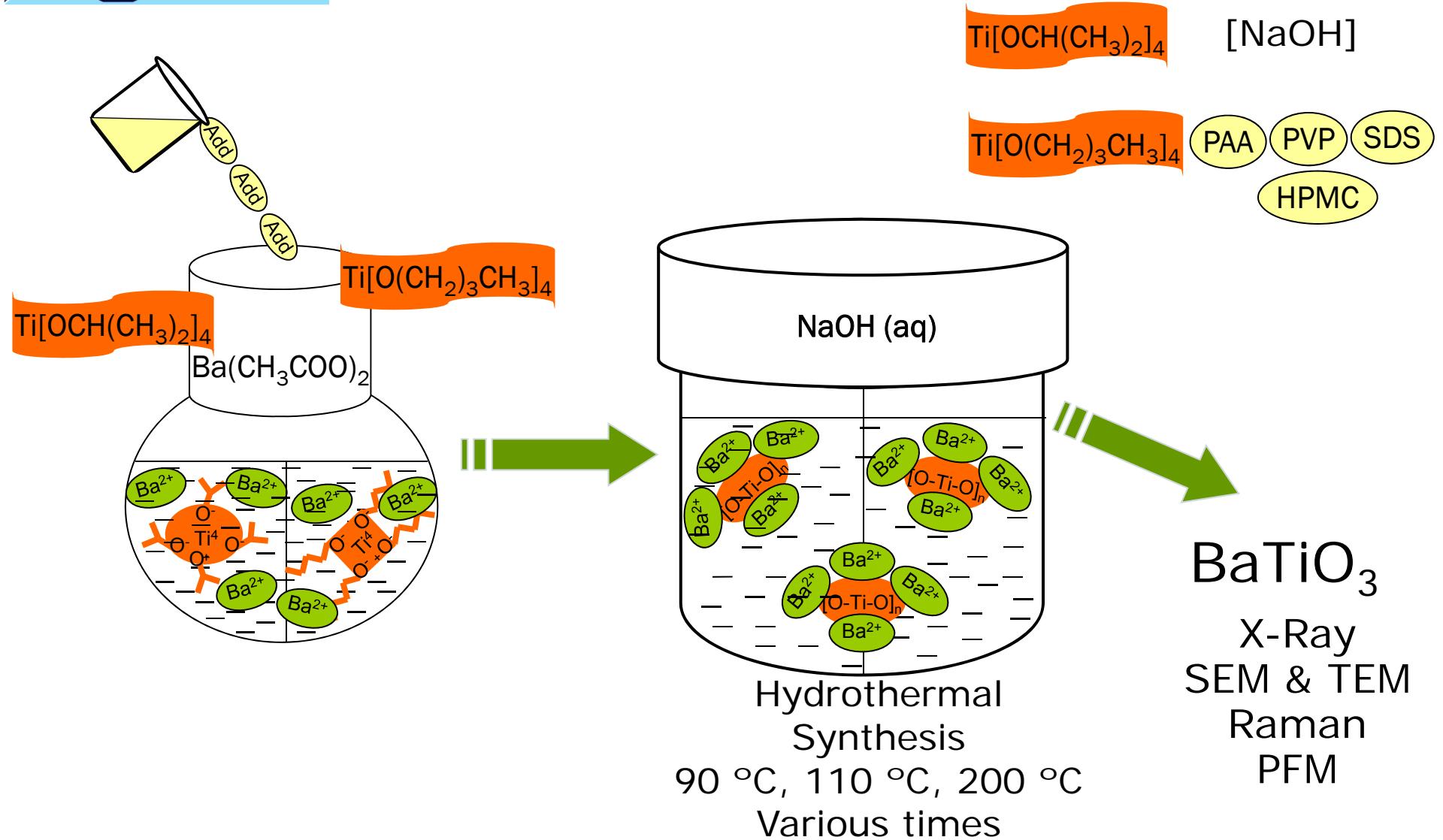
Non Template Strategy

A 12-a ediție a Seminarului Național de Nanoștiință și Nanotehnologie,
Biblioteca Academiei Române, București

16 mai 2013

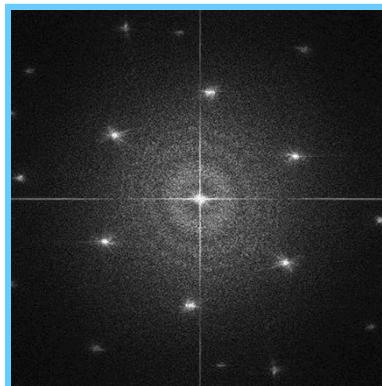
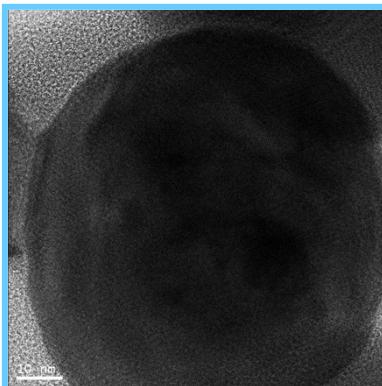
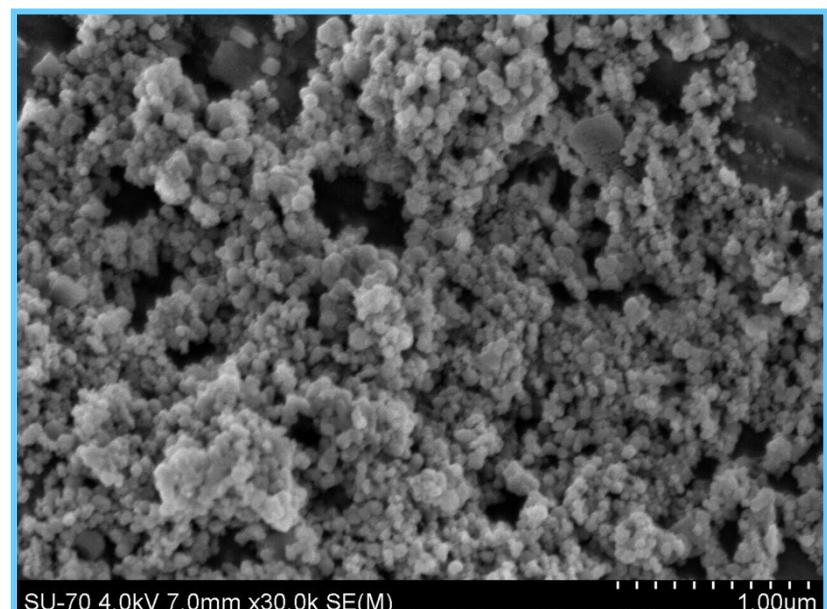
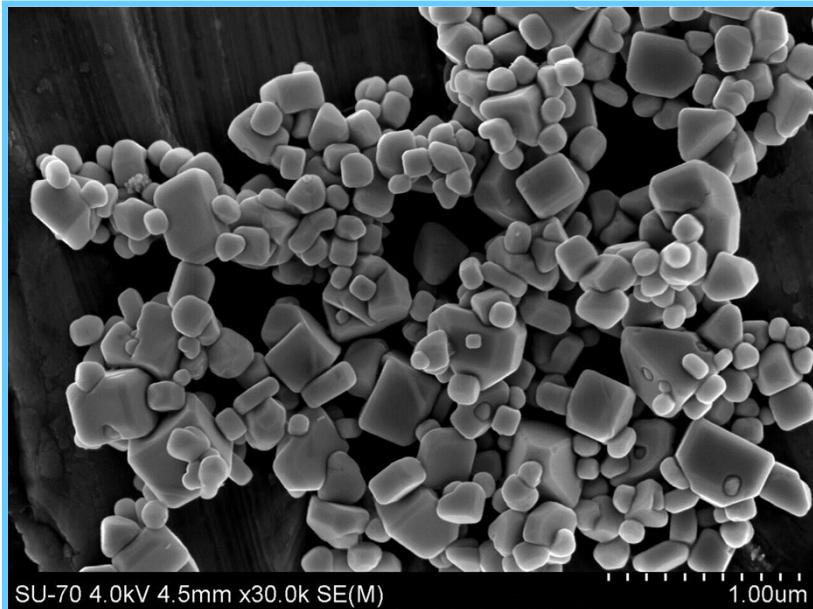


NonTemplate - Experimental





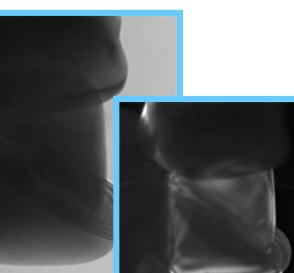
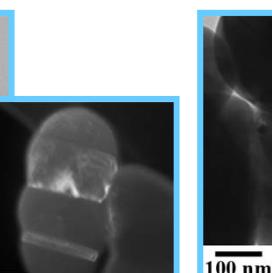
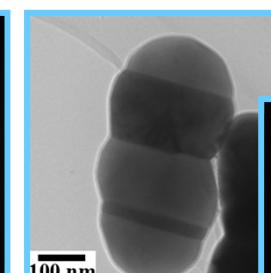
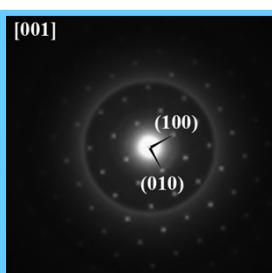
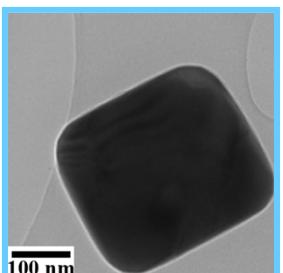
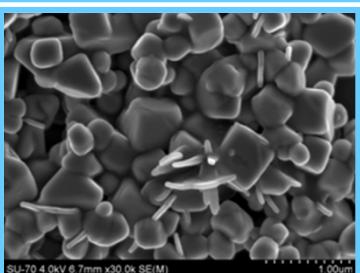
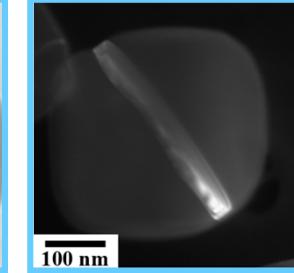
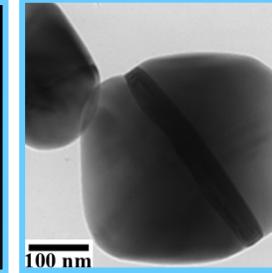
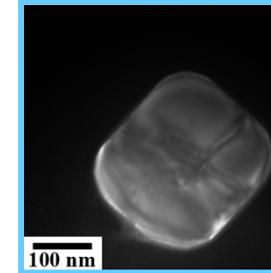
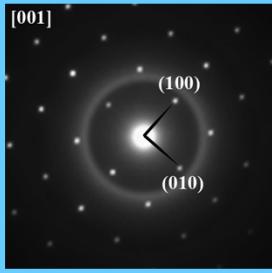
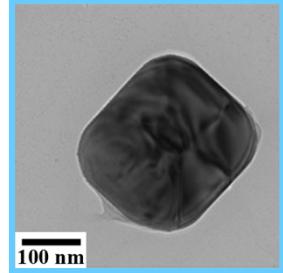
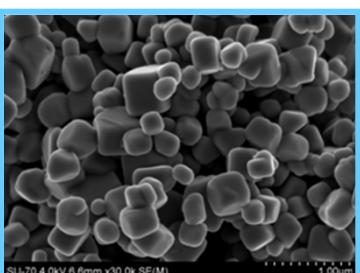
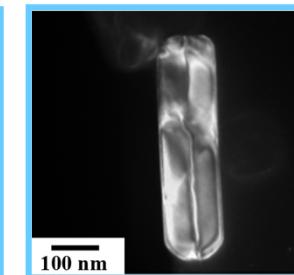
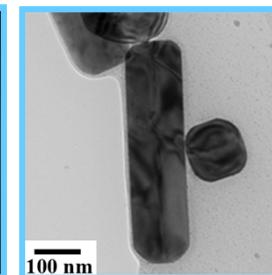
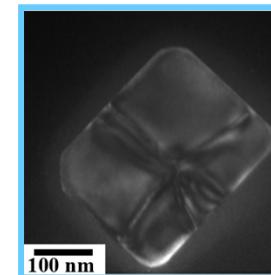
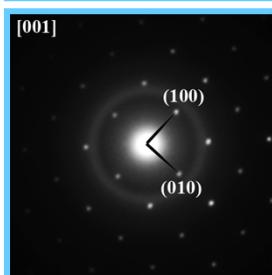
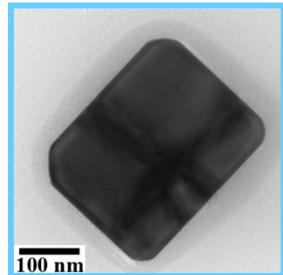
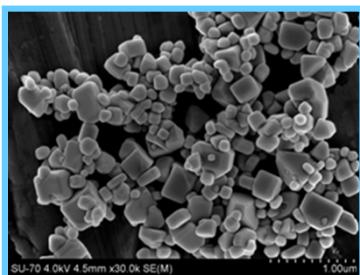
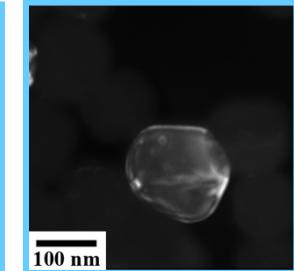
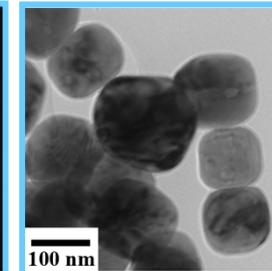
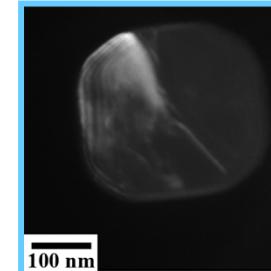
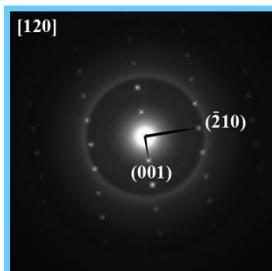
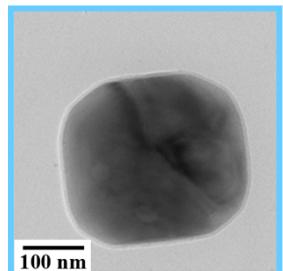
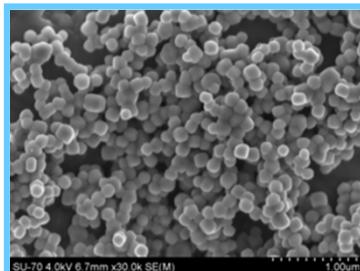
Morphology – Ti precursor





Morphology – NaOH concentration

$\text{Ti}[\text{OCH}(\text{CH}_3)_2]_4$

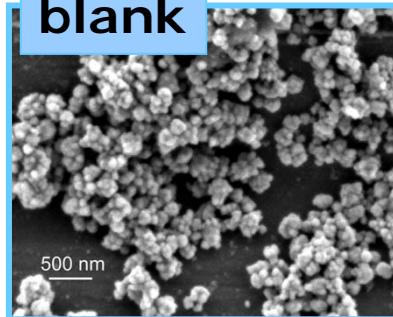




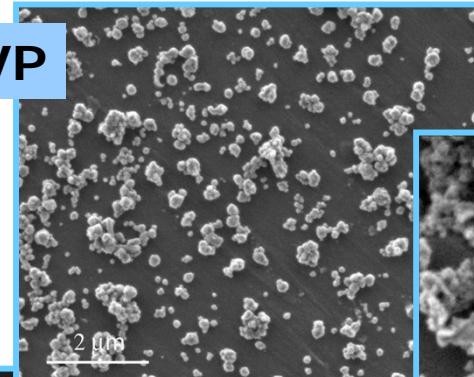
Morphology – Additives



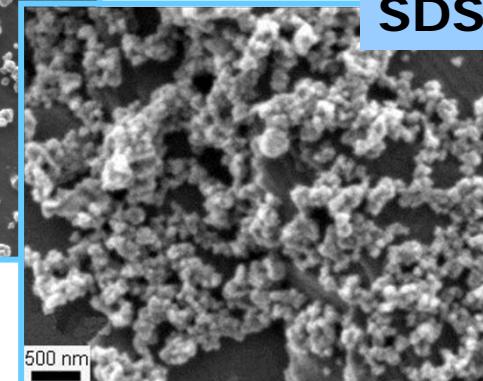
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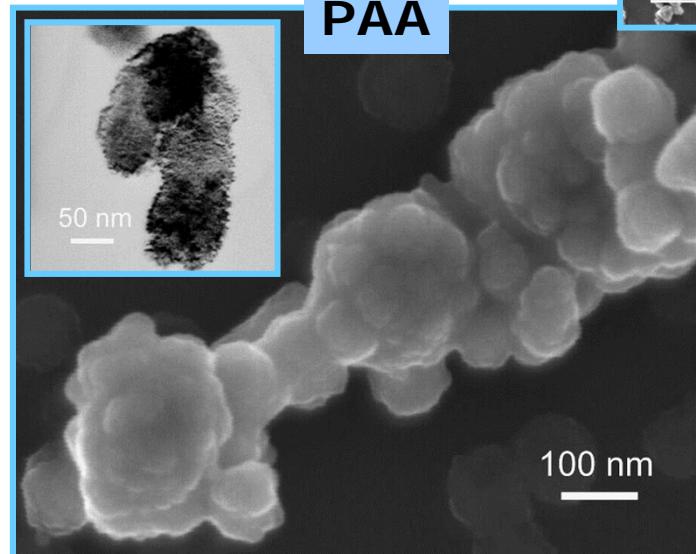
PVP



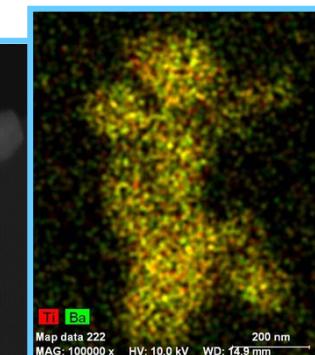
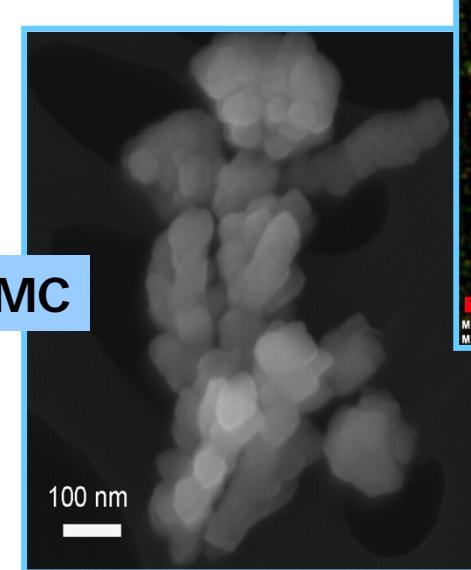
SDS



PAA



HPMC





Conclusions

Template

Chemical template using TiNTs

TiNTs induce the anisotropic growth of BT

Non-template

Additive assisted using Ti alkoxides

Different Ti precursors – different morphologies of BT particles

The structure and the morphology of BT nanoparticles can be controlled by hydrothermal synthesis





ACKNOWLEDGEMENTS



PhD supervisors:

Prof. Dr. Paula Vilarinho

Dr. Paula Ferreira

Post-doc supervisors:

Prof. Dr. Joaquim Vieira

Prof. Dr. Augusto Lopes



Scientific mentor:

Dr. Speranta Tanasescu



PN-II-RU-TE-2011-3-0160

Team members:

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