# SCIENCESPRINGDAY

FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

Department of Materials Science – CENIMAT|I3N

# Solution Synthesis of Dielectrics

CENIMAT|I3N/ Microelectronic and Optoelectronics Group


## Rita Branquinho

Post-Doc Researcher

ritasba@campus.fct.unl.pt


♦2012 PhD. Biodetection based on field effect devices.

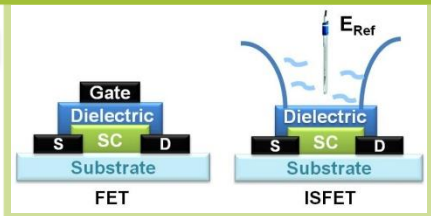
♦2003 Post-graduation in Analytical Chemistry, FCUL.

♦ 2002 Graduation in Chemistry, FCUL.

## Objectives

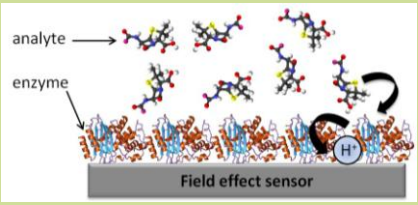
### Auto-combustion synthesis of high-*k* dielectrics

The auto-combustion synthesis is based on a solution of the required metal salt (oxidizing agent) and an organic fuel employed as reducing agent. This redox mixture ignites upon heating at a relatively low temperature, to initiate a self-propagating exothermic reaction that sustains high temperatures yielding the metal oxide.




### Application in electronic and biosensor devices

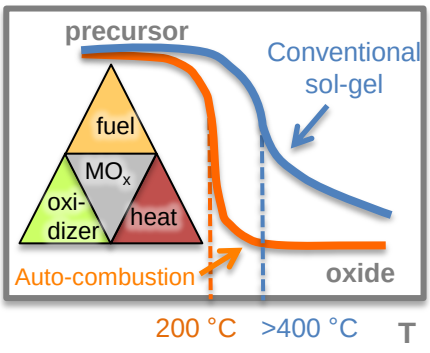
- Development and characterization of solution based electronic devices – TFTs and capacitors.
- Development of solution processed field effect biosensors – EIS and ISFETs for pH, enzymatic reaction and DNA detection; where the dielectric acts as the sensitive layer.



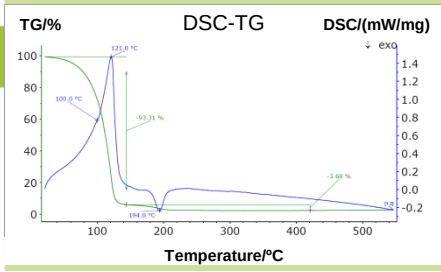

## Methodology

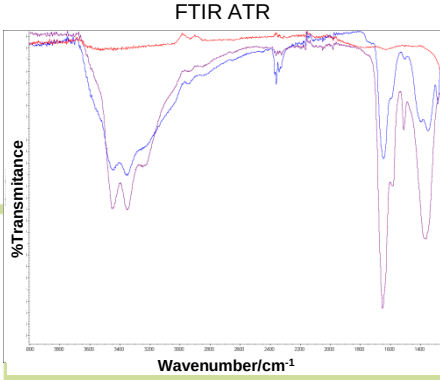
$$M(oxidizer)_x + Fuel \xrightarrow[Solvent]{\Delta T} MO_x + H_2O + CO_2 + N_2$$

| M(oxidizer)$_x$ | Fuel | Solvent | $MO_x$ |
|---|---|---|---|
| -$NO_3$ | Urea | MetoxyEt | $Al_2O_3$ |
| -acac | Glycine | Water | $Ta_2O_5$ |
| -Cl + $NH_4NO_3$ | Citric acid | | $HfO_2$; ... |




The auto-combustion synthesis requires the study of several parameters to yield uniform thin films at low-temperatures. Variables such as: metal ion nature and concentration; nature of oxidizer (MClx requires a combustion aid; $NH_4NO_3$); nature of fuel (which controls the reaction rate); fuel/oxidizer ratio ($\phi$); type of solvent; must be optimized to obtain high quality films. The deposition (spin-coating and inkjet printing) and annealing processes also need to be optimized.




## Expected Results

- Optimization of the precursor solutions for high quality and uniformity dielectric oxide thin films with high dielectric constant.
- Development of printable precursor solutions to allow direct patterning of the dielectric layers by inkjet printing.
- Development of low temperature high quality solution based dielectric thin films for electronic devices – TFTs and capacitors.
- Development of pH sensitive solution based dielectric thin films for field effect biosensors – EIS and ISFETs for pH, enzymatic reaction and DNA detection.


Funding:

POINTS
Printable Organic-Inorganic Transparent Semiconductor Devices

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR