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ZnO nanostructures and applications

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Introduction

ZnO is a promising multifunctional, n-type semiconductor material, with a wide and direct band gap of about 3.37 eV and a large free exciton binding energy of 60 meV at room temperature which allows it to act as an efficient semiconductor material. Is biocompatible and also displays piezoelectric properties. Due to these different properties, ZnO is used in various bio, micro and nano electronic applications, such as thin film transistors, dye-sensitized solar cells, UV/ozone sensors, piezoelectric devices, photocatalysis, SERS, glucose sensor and in biomedical science as antibacterial and antifungal agents [1]–[3].

For this propose, different growth techniques, precursors and solvents are continuous being employed to prepare a variety of different ZnO nanostructures, like chemical vapour deposition, electrodeposition, electrospinning, LAFD (laser assisted flow deposition) and hydrothermal method, whether by conventional heating or assisted by microwave radiation.

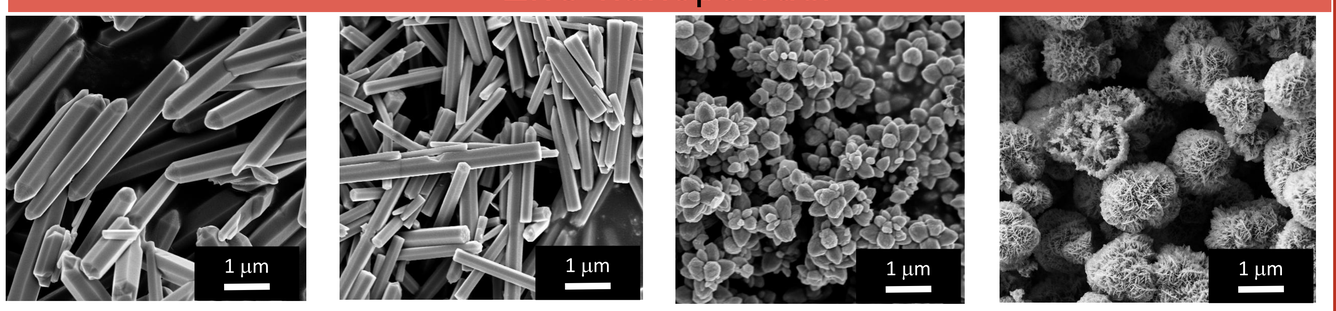
With this work ZnO nanostructures are synthesized in few minutes and different types of substrates can be used (glass, PEN, tetrapak and cellulosic based substrates), serving for different areas of applications.

ZnO Microwave Synthesis

Microwave production

- Temperature: 70 ºC to 150 ºC
- Synthesis time: 5 min to 60 min
- Power: 50 W to 100 W
- Precursors: Zinc Nitrate or Zinc acetate
- Solvents: Water, Ethylene Glycol, 2-ethoxyethanol, Ethyl Acetate

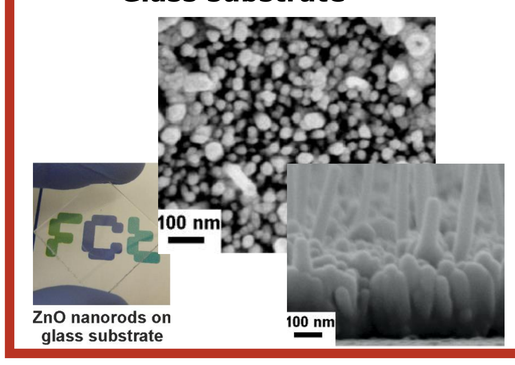
ZnO nanopowder



Water | **2 - ethoxyethanol** | **Ethylene Glycol** | **Ethyl Acetate**

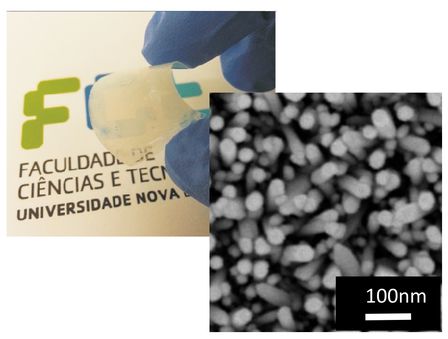
Nanorods arrays

Glass substrate

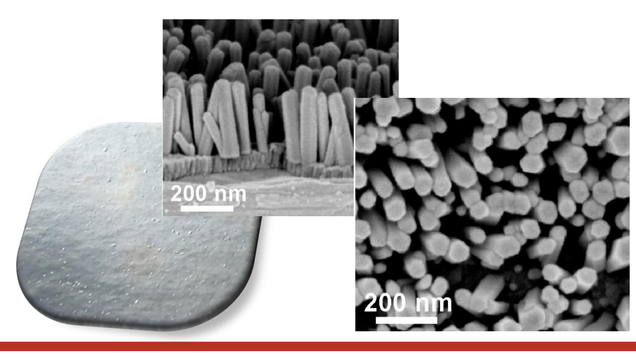


ZnO nanorods on glass substrate

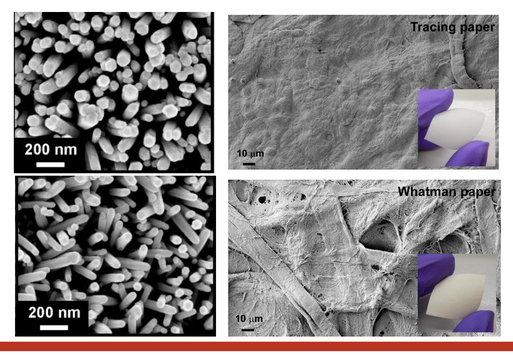
PEN substrate



Tetrapak substrate

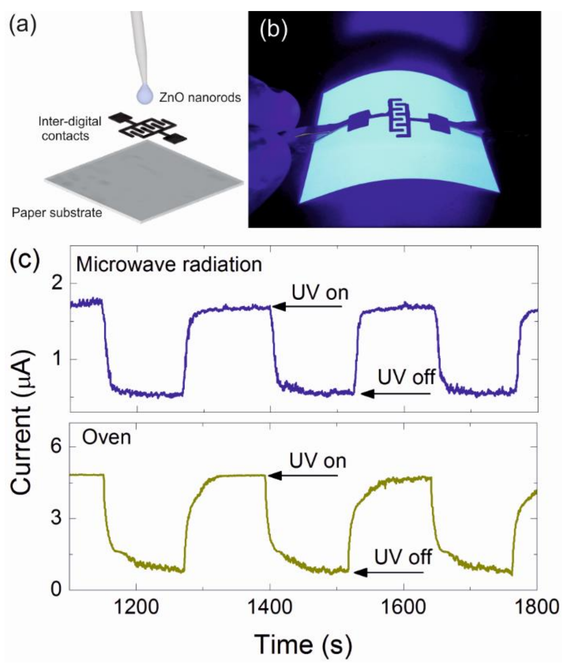


Paper substrate

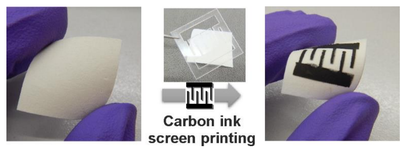


ZnO Applications

UV Sensors

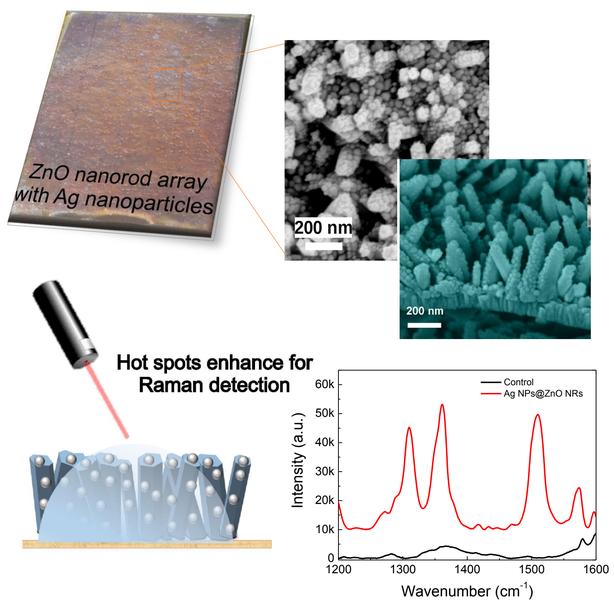


(a) Scheme of the interdigital contacts used to test the ZnO nanorods as UV sensor; (b) paper under the UV light; and (c) cycling behavior of ZnO nanorod based UV sensors.

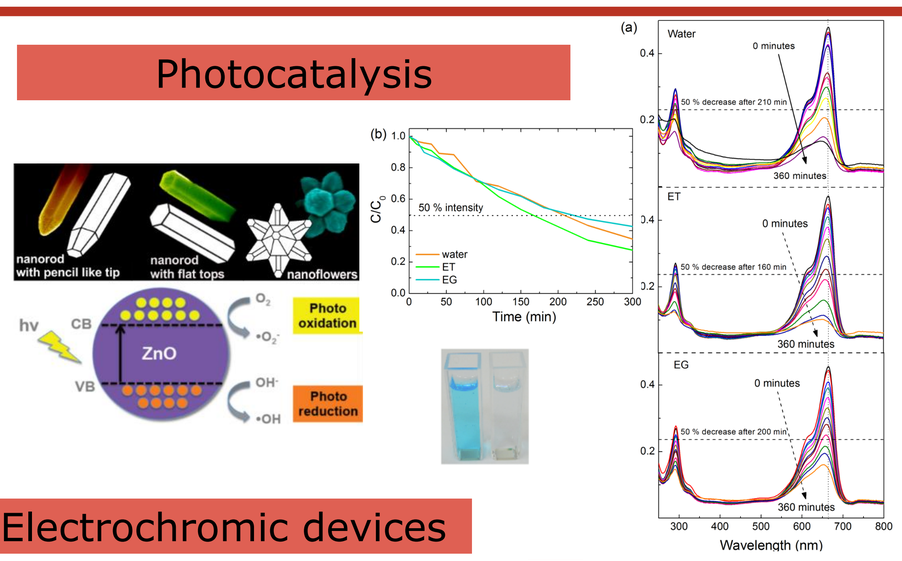


Construction of a UV nanorods array sensor on paper substrate

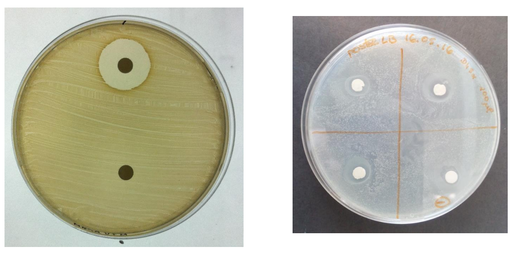
SERS
(Surface enhanced Raman Spectroscopy)



Photocatalysis

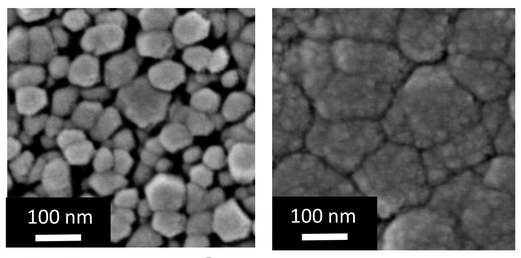


Bacterial inactivators



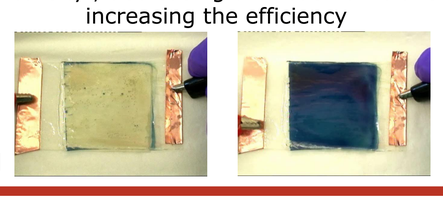
Staphylococcus aureus, MRSA (ATCC 33591)

Electrochromic devices



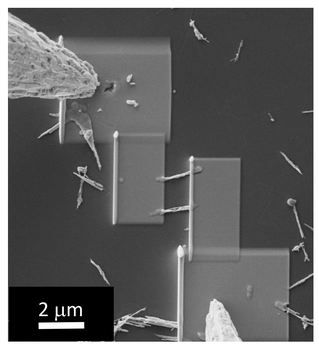
ZnO nanorods array | **WO_3 on ZnO nanorods array**

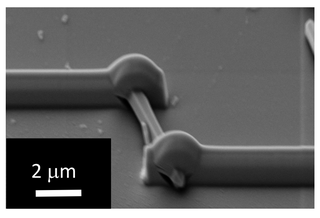
Using ZnO nanorods in electrochromic devices it is expected that WO3 grow on the surface with large surface to volume ratio, increasing the colored intensity , decreasing the redox time and increasing the efficiency



bleached | colored

NanoFETs





References

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[3] A. Araújo, A. Pimentel, M.J. Oliveira, M.J. Mendes, R. Franco, E. Fortunato, H. Águas, R. Martins, *Flex. Print. Electron.* **2017**, *2*, 14001.

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