Carbon Dots as a Fluorescence pH Nanosensor by Application of an Active Surface Preservation Strategy

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CSAC 2021

1st International Electronic Conference on Chemical Sensors and Analytical Chemistry

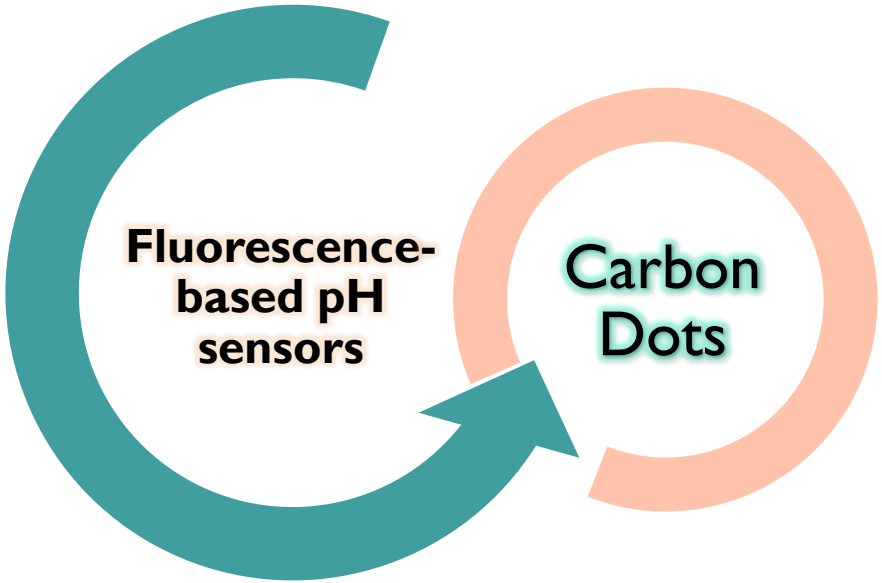
01-15 July 2021

pH monitorization

Applications

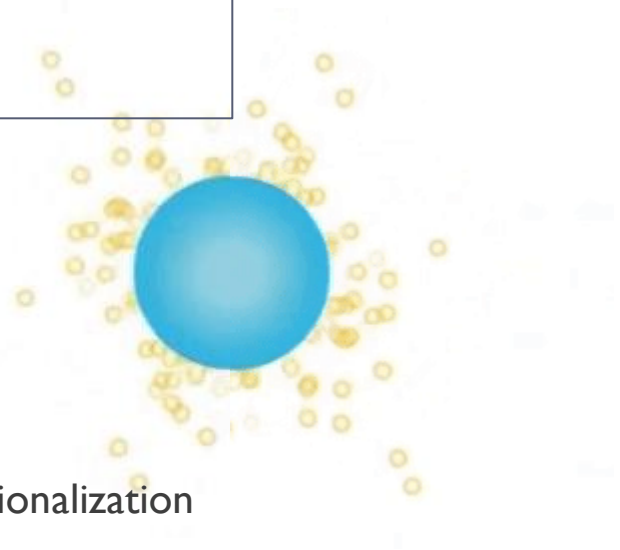
- Environmental
- Industrial
- Biomedical

- ✘ Temperature-dependent response
- ✘ Rigid design
- ✘ Fragility



Carbon Dots

Carbon Based Fluorescent Nanoparticles



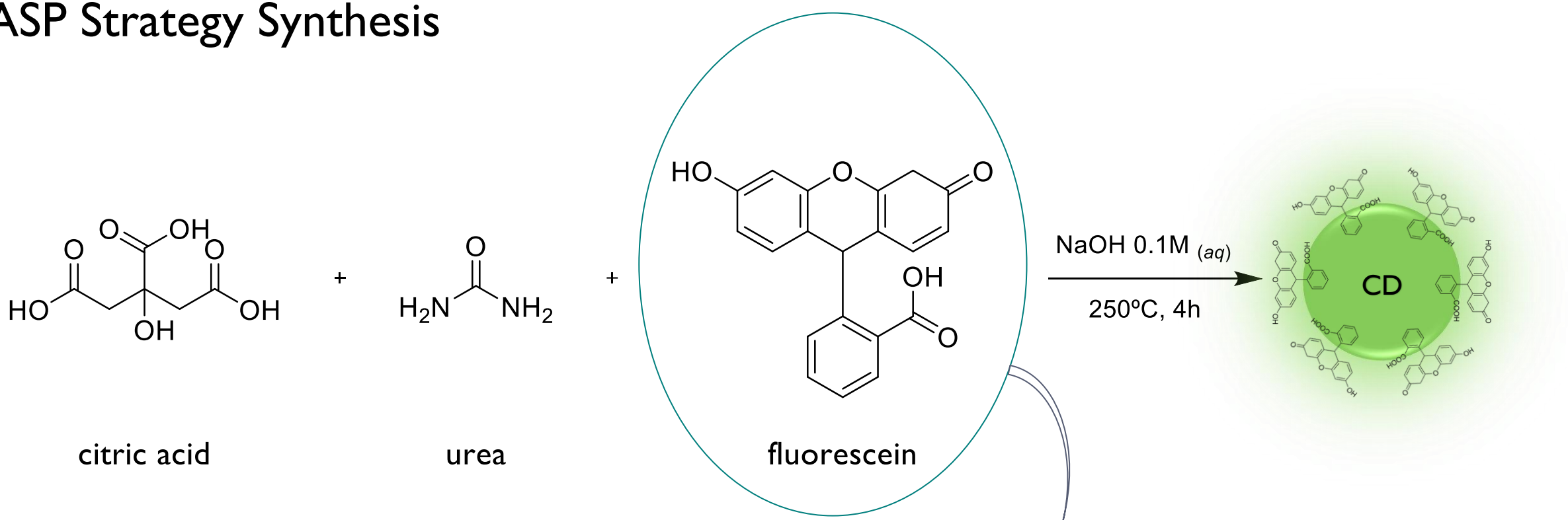
Advantages

- ✓ High photoluminescence
- ✓ High aqueous solubility
- ✓ Low cost
- ✓ Low toxicity
- ✓ Good biocompatibility

Challenges so far

- × Arbitrary target analytes
- × Intricate post-synthesis functionalization steps
- × Limited range of pH
- × Interfering potentials in complex media

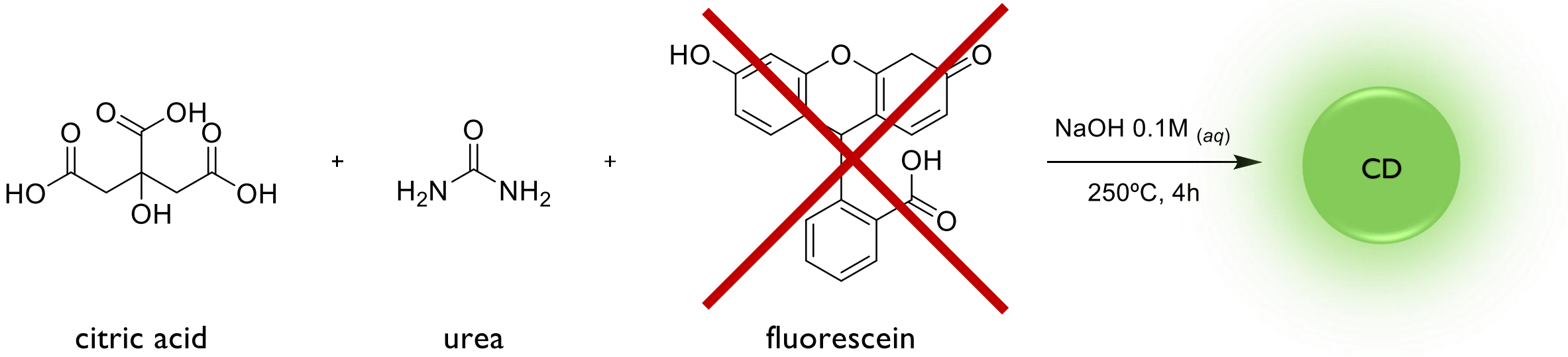
ASP Strategy Synthesis



Active Surface Preservation (ASP) Strategy

- Development of CDs with fluorescein-like structures preserved on their surface

For Comparison Effect



citric acid urea fluorescein

CD without Fluorescein

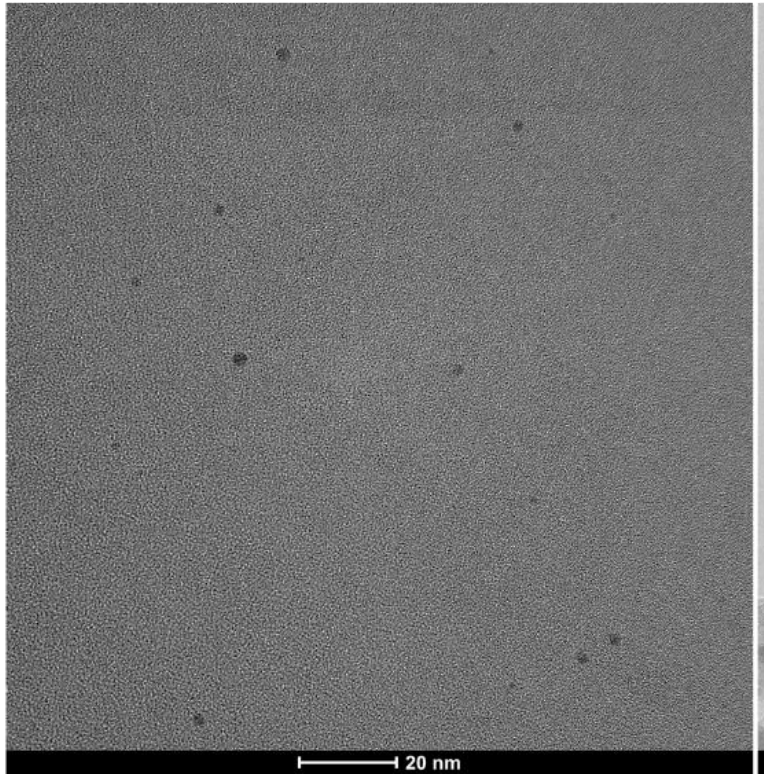
Morphological Characterization

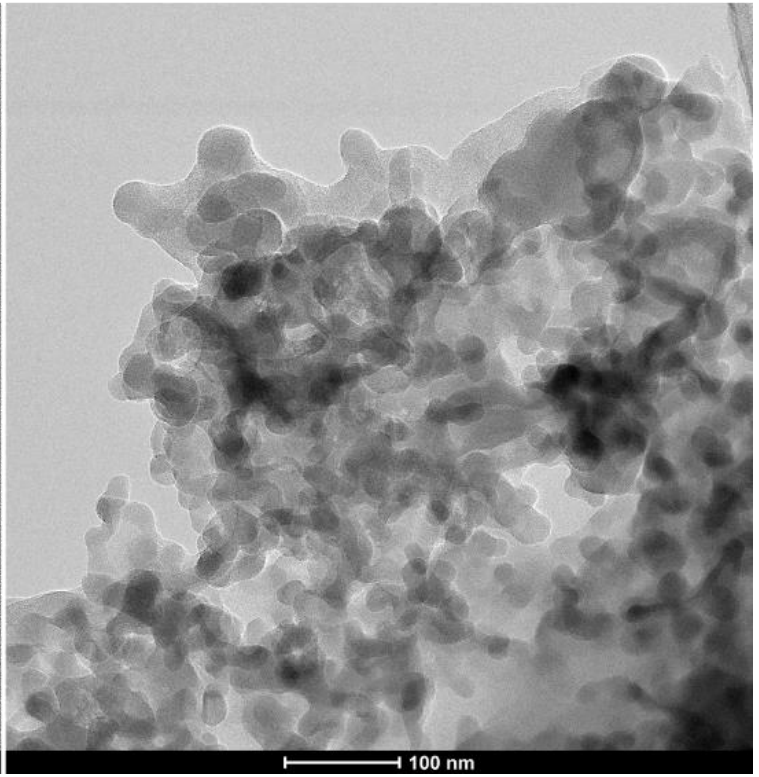
CDs without Fluorescein

- Carbonaceous amorphous structure
- Mean diameter of 2.5nm

CDs with Fluorescein

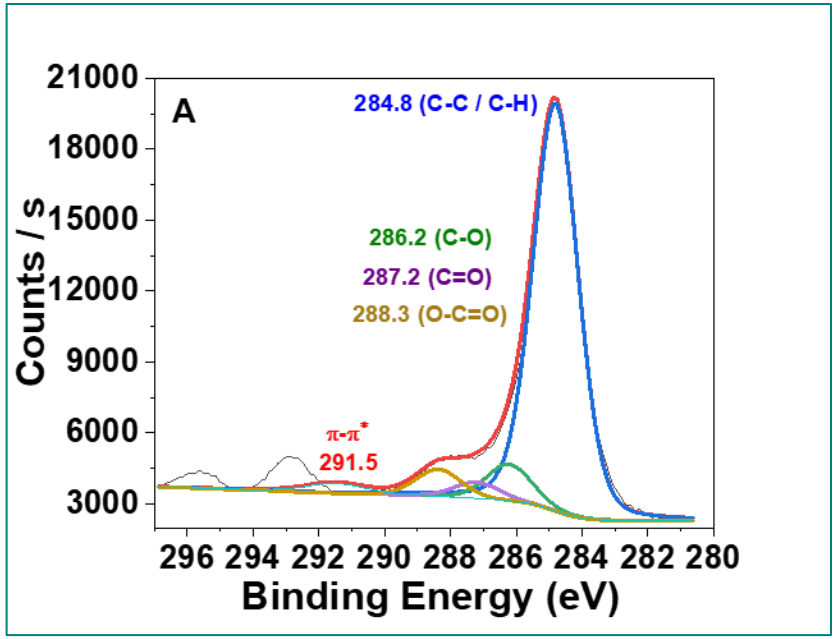
- Aggregated carbon nanoparticles
- Mean diameter of 27nm



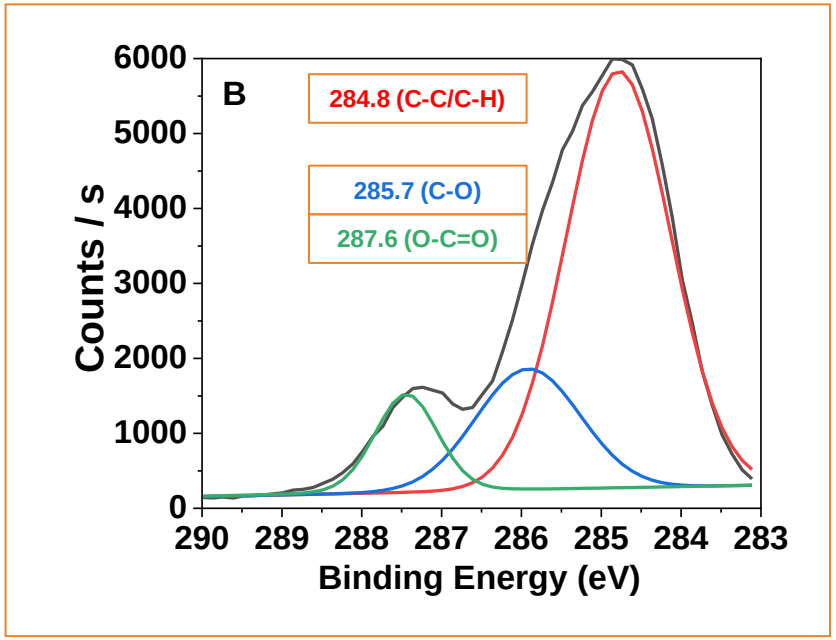


XPS Analysis

Chemical surface composition (%)	
C 1s	77%
N 1s	3%
O 1s	17%



CD with Fluorescein

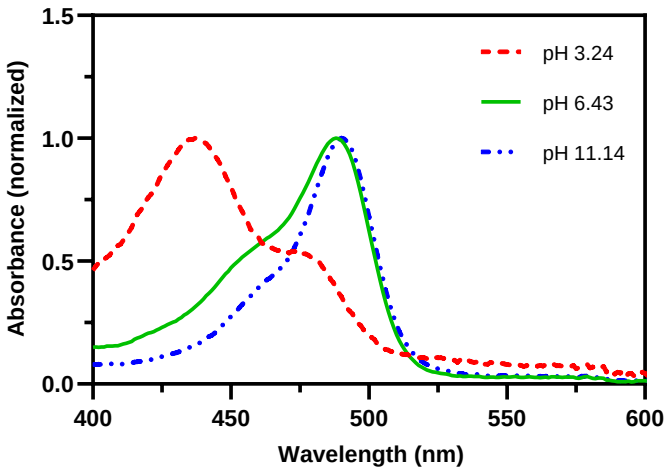


CD without Fluorescein

UV-Vis Analysis

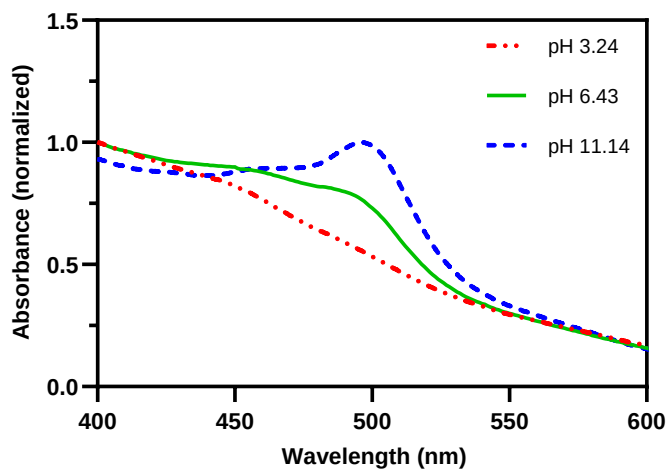
Fluorescein

- Band at ~440nm in acid pH
- Red-shift to ~490nm in basic pH



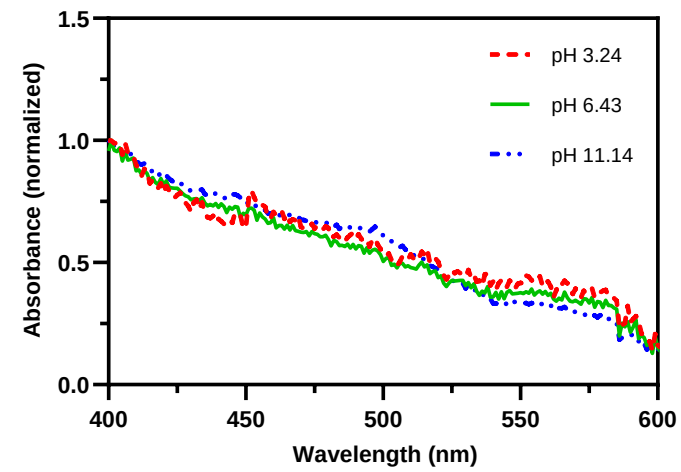
CDs with Fluorescein

- ~500nm band formation in basic pH
- Intensity ∝ pH

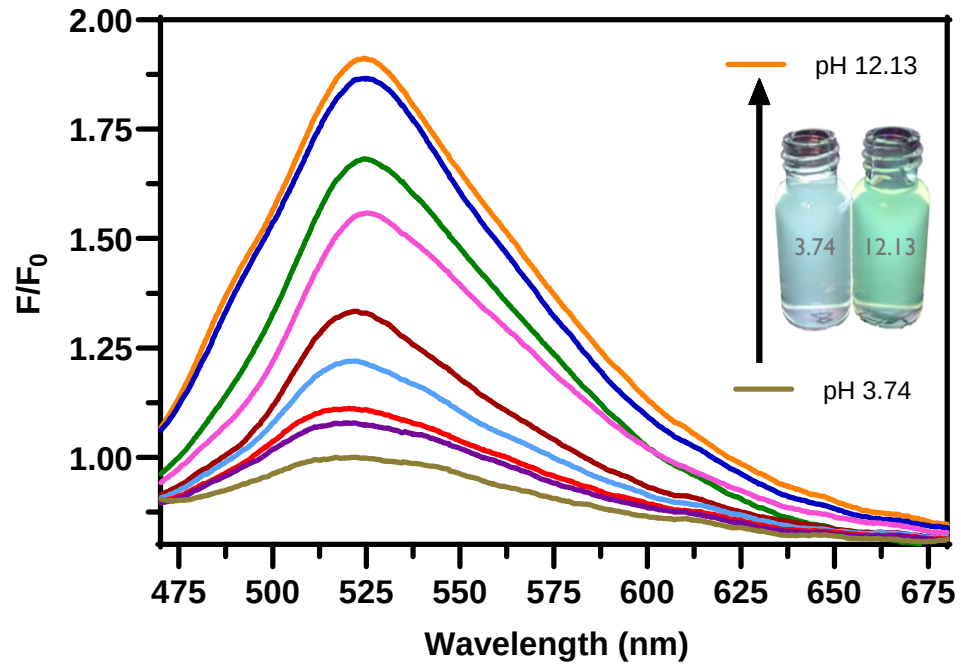


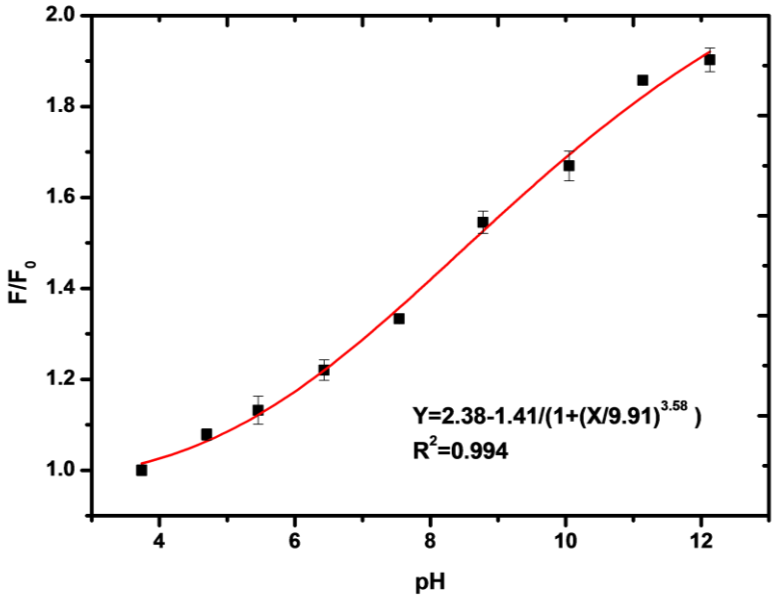
CDs without Fluorescein

- No band at ~500nm
- No pH-sensitive response



pH-response



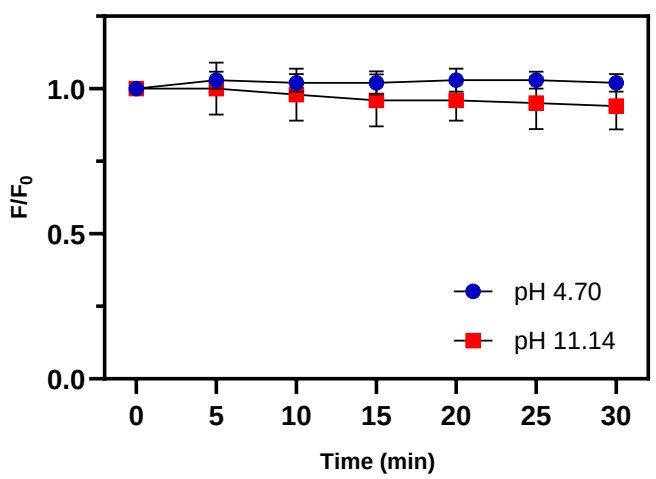


- Excitation wavelength of 450nm
- Fluorescence intensity maximum at 525nm

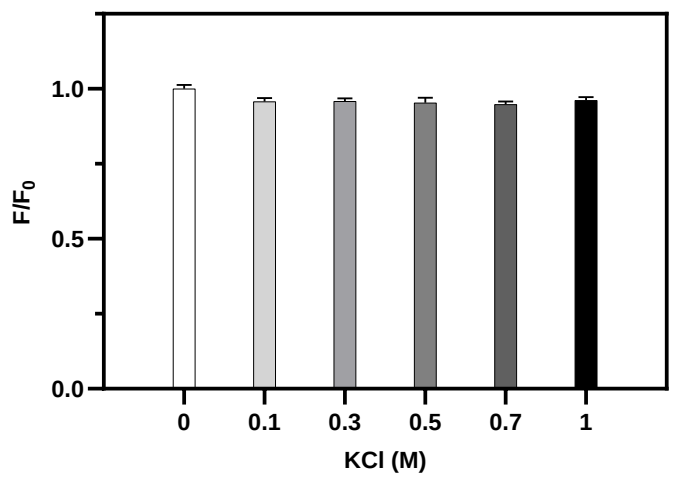
➢ Fluorescence enhancement with increasing pH

pH-response

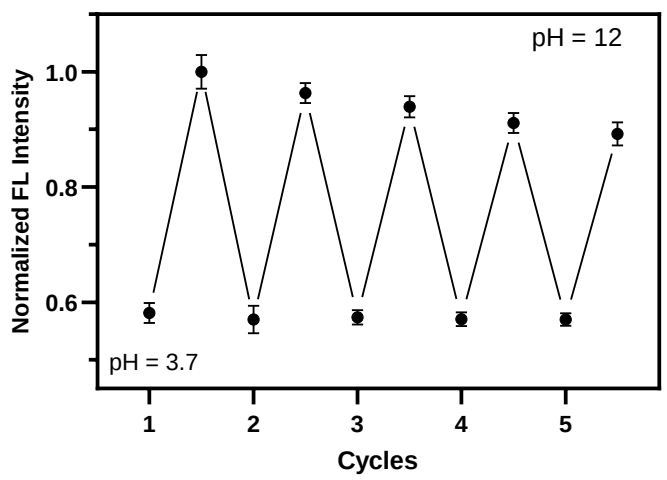
- ✓ Photostable under visible light irradiation
- ✓ Stable towards variations of the ionic strength
- ✓ Negligible effect in fluorescent intensity in the presence of interferents
- ✓ Good pH reversibility



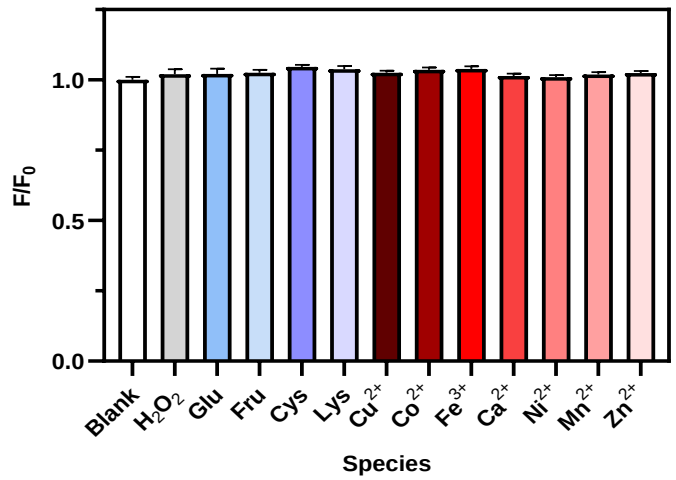
Photostability assay



Ionic strength effect study



pH reversibility study



Interference study

Real Water Samples

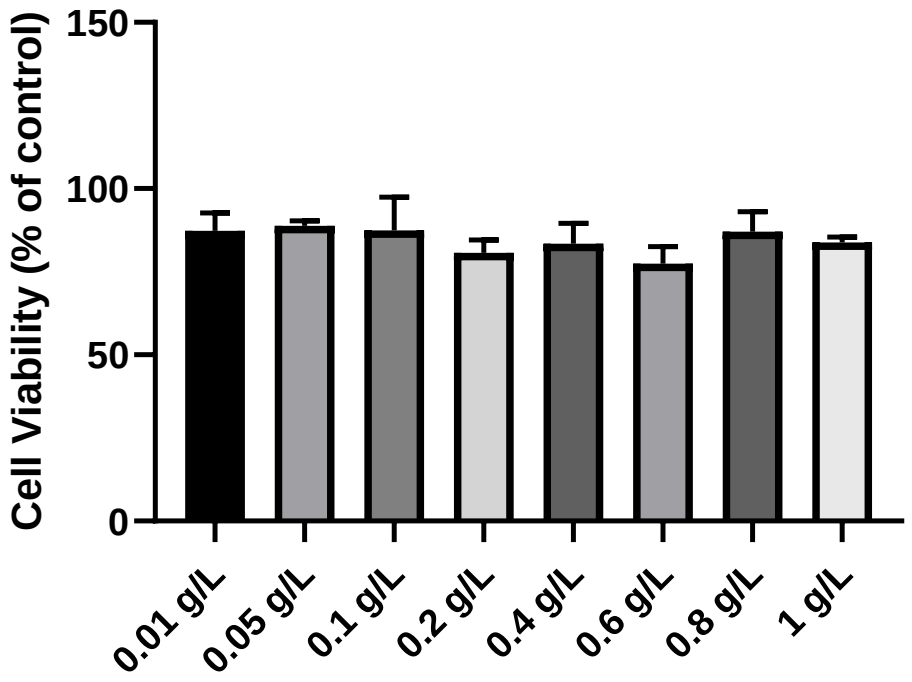
	Laboratory	Residence
pH-meter with pH electrode	7.93 ± 0.01	7.99 ± 0.05
Fluorescence measurement with CD_F	7.59 ± 0.04	7.69 ± 0.18

Samples obtained from tap water from two locations of the Porto Municipal area

Biocompatibility

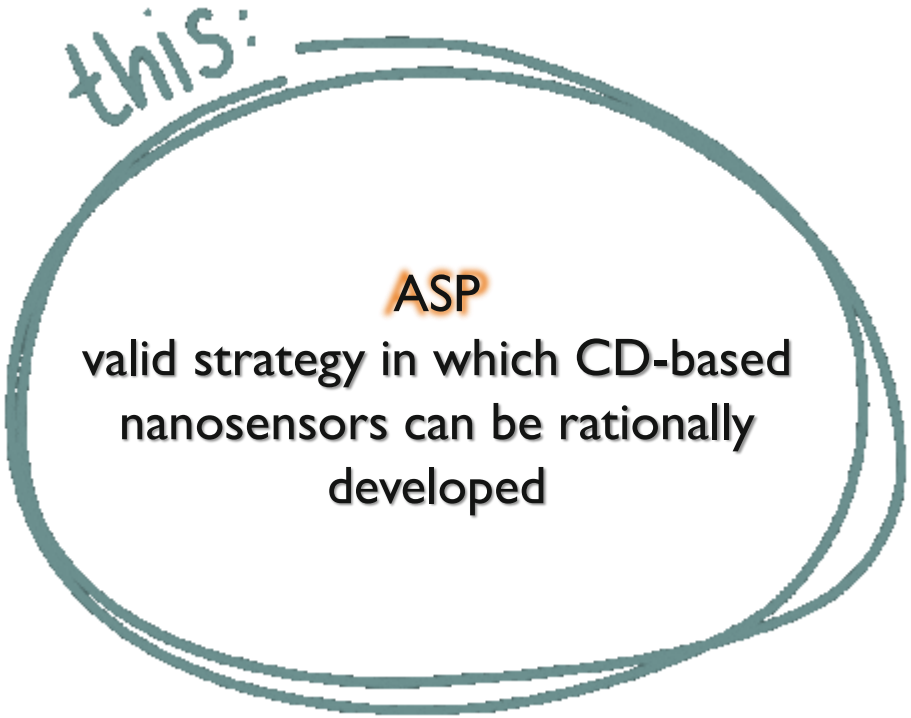
MTT viability assay

- SH-SY5Y, Human Neuroblastoma Cell Line
- No significant drop in cell viability



Summing up

- Fluorescent pH nanosensor was developed via ASP strategy
- Determined pH values from 3.7 to 12.1
- pH-selectivity, reversibility and photostability
- Biocompatible with human cells



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THANK YOU FOR YOUR ATTENTION

CARBON DOTS AS A FLUORESCENCE PH NANOSENSOR BY APPLICATION OF AN ACTIVE SURFACE PRESERVATION STRATEGY

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Special thanks to my advisors:

CIQUP — **Prof. Dr. Carlos Pereira**
Dr. Luís Pinto da Silva

Acknowledgments:

UNIVERSIDAD DE MÁLAGA — **Maria del Valle Martínez de Yuso, Manuel Algarra**
HR-TEM & XPS

U.PORTO FMUP FACULDADE DE MEDICINA UNIVERSIDADE DO PORTO — **Nuno Vale**
MTT viability assay