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A Rapid, Green and Cost-Effective Synthesis of pH- and Hydroxyl Group-Sensitive Carbon Dots for Sensing Applications

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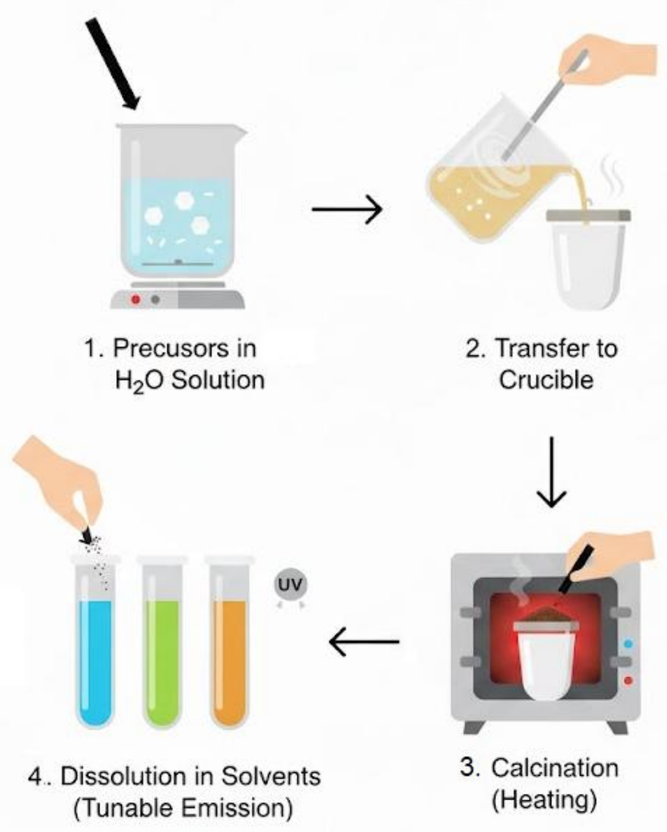
INTRODUCTION & AIM

Carbon Dots (CDs) are graphene-like nanomaterials exhibiting tunable luminescence attractive for bioimaging and sensing [1]. Their sensitivity to environmental changes has led to applications in detecting various analytes and as pH sensors [2, 3, 4], even differentiating alcohols like MeOH and EtOH via fluorescence quenching [5]. In this study, we synthesized CDs using a **simple, low-cost, and greener combustion method** with safe precursors (citric acid and urea), preserving excellent optical performance. The resulting CDs display **solvent-dependent spectral behavior**, including distinct emission shifts in alcohols, and importantly, show **continuous and reversible fluorescence wavelength shifts over a broad pH range**. These features, combined with their biocompatibility and high quantum yield, underscore their strong potential for applications in diagnostics, sensing, and the food industry.

METHOD



Carbon dots were synthesized by mixing citric acid (CA), urea (U), and sodium hydroxide in a ratio of 1:1:0.4 in an aqueous solution. The resulting solution was then subjected to pyrolysis at 260 ^{o}C for 5 h.

To futher research powder was dissolved in different solvents:

H_2O, pH 1-14, EtOH, MeOH, pentanol, acetonitrile, Polyethylene glycol (PEG), glicerine,

RESULTS & DISCUSSION

Structure and morphology

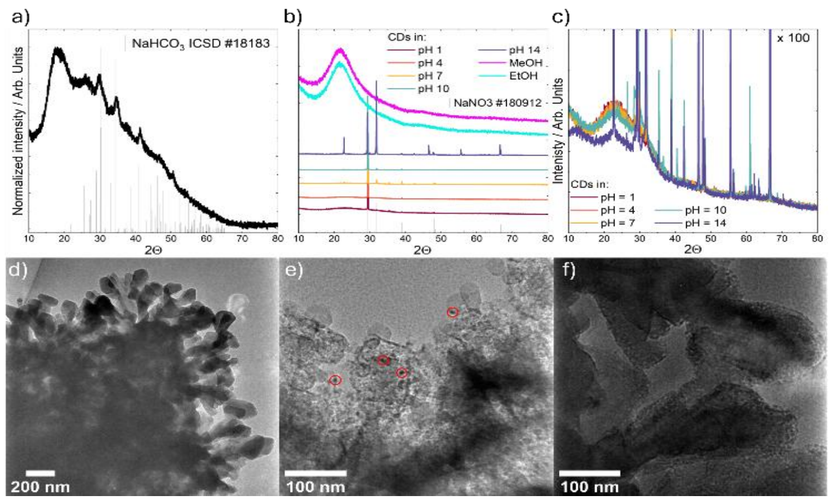


Figure 1. XRD diffractogram for a) pure CDs, b,c) CDs in solutions, d-f) TEM images of pure CDs for different magnification, red circle show carbon dots.

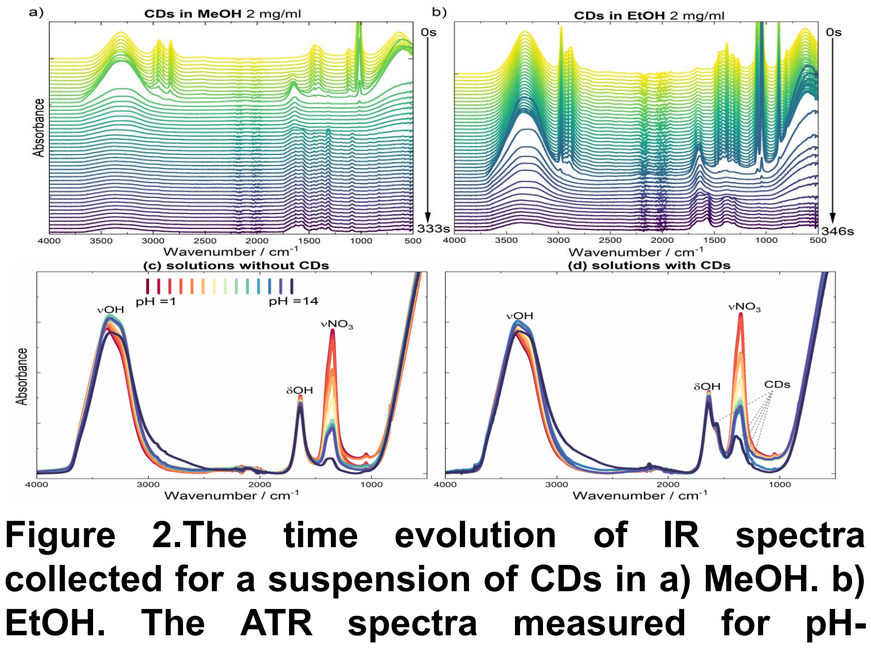


Figure 2.The time evolution of IR spectra collected for a suspension of CDs in a) MeOH. b) EtOH. The ATR spectra measured for pH-dependent solutions without (c) and with (d) CDs.

Optical characterization

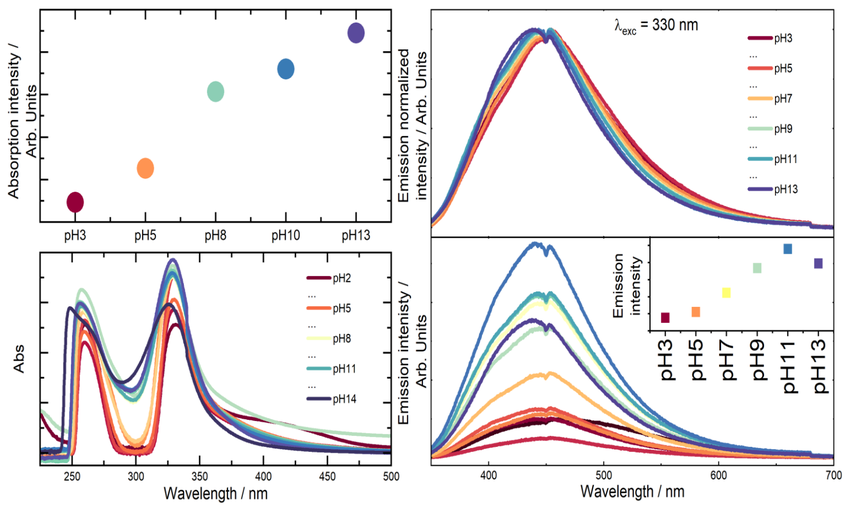


Figure 3. Absorption and emission spectra of CDs in solvents with different pH

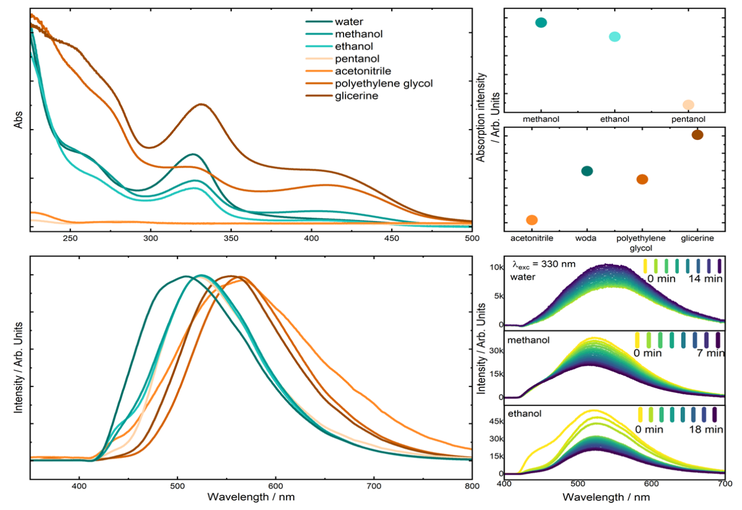


Figure 4. Absorption and emission spectra of CDs in organic solvents, time-based emission measurements

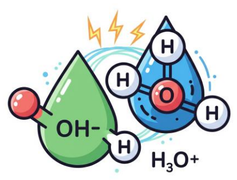
CONCLUSION

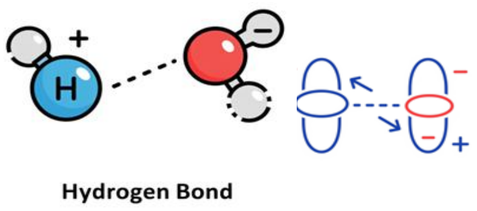
Interaction mechanism

Both pH and solvent type influence CDs fluorescence in different ways:

Water
Dominated by ionic interactions

Solvent
Hydrogen bonding and dipole interactions





- **Emission changes depend on solvent type** → enables methanol/ethanol detection.
- **Emission shifts correlate with OH group content and carbon chain length** → intermolecular interactions affect photoluminescence
- **Emission evolves over time** → surface reorganization and solvent interactions.
- **pH and solvent affect emission differently** → highlights role of OH^- vs. molecular OH.

FUTURE WORK / REFERENCES

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