N-Doped Porous Carbon Structures and Pyrrole Deposited Boron-Doped Diamond Electrodes for Advanced Energy Storage

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21.01.2025 – 20.01.2027

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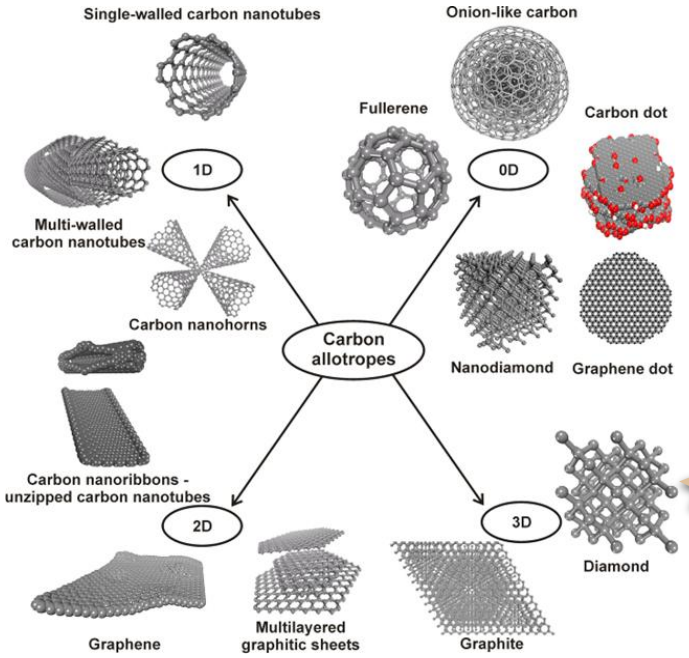
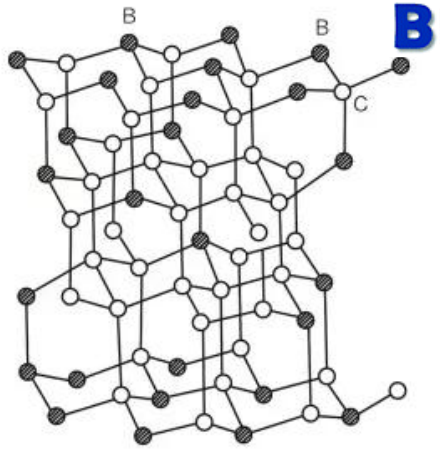
FZU

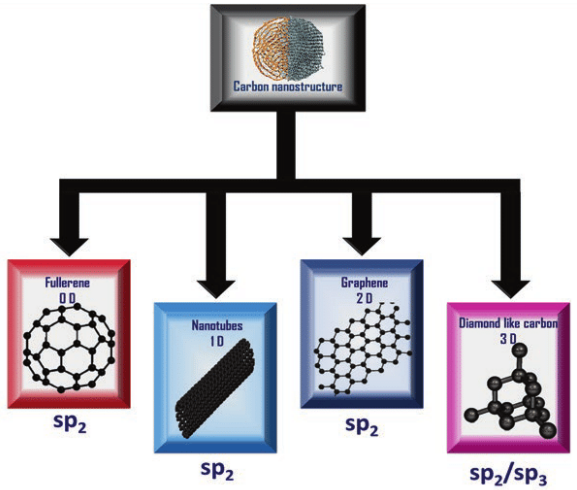
Co-funded by the European Union

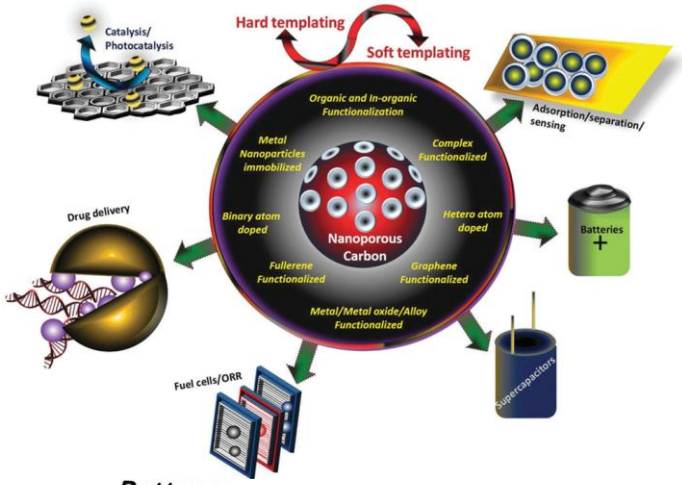
Project Introduction

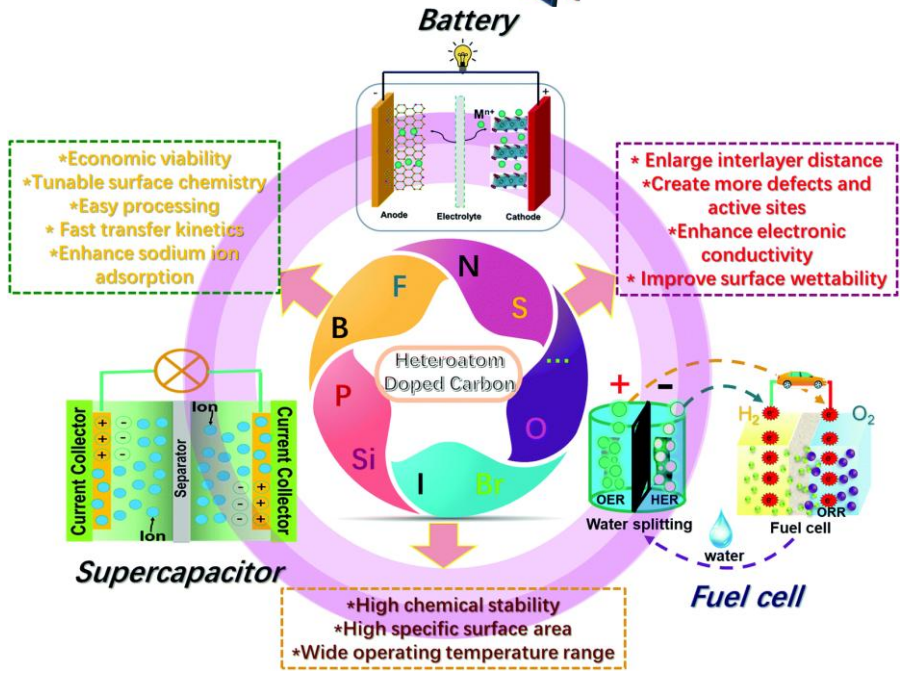




BDD electrode







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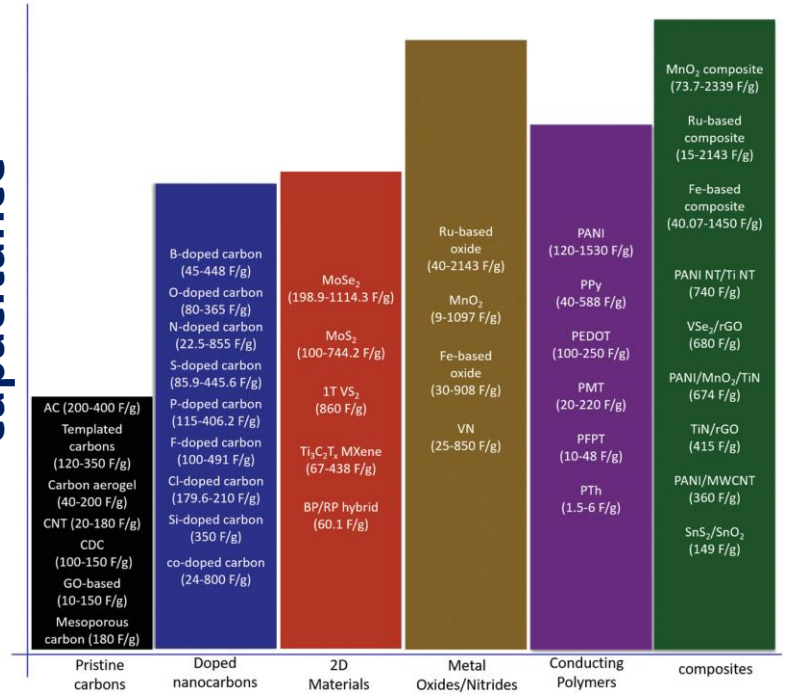
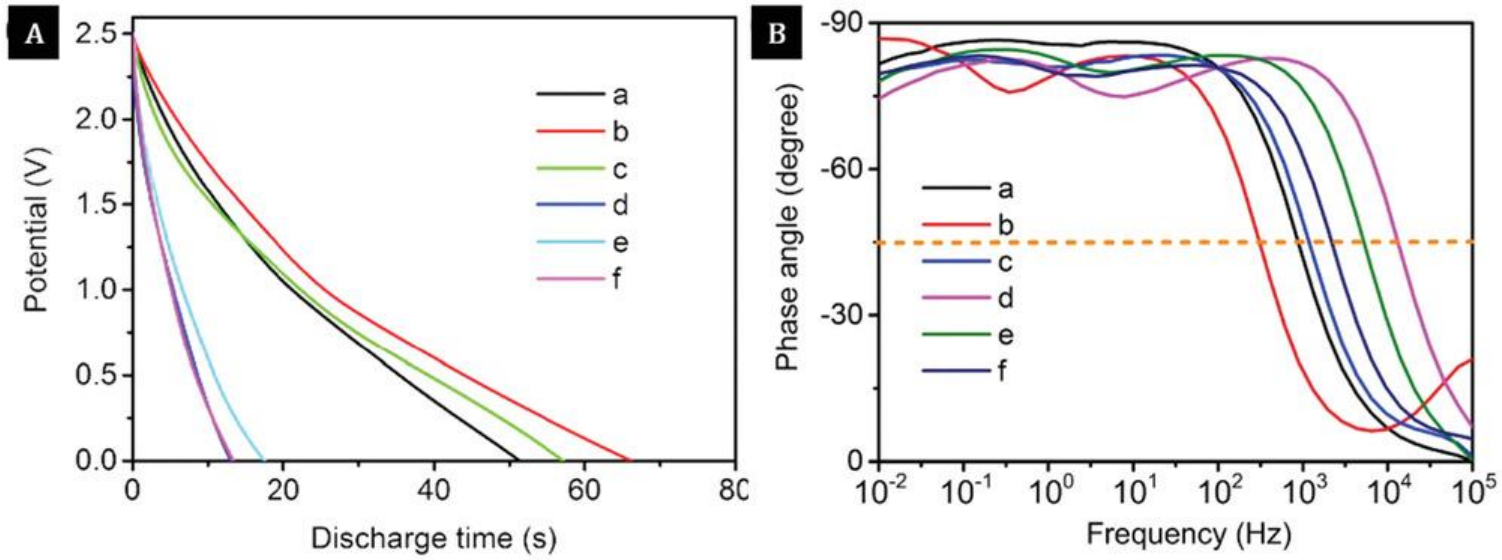
Significance of N and B doping





a) pristine; b) N-doped; c) B-doped; d) P/N-doped; e) B/N-doped; and f) Si-doped carbon nanostructures

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Z.J. Han et al. / Carbon 126 (2018) 305-312

Research plan

- ✓ Synthesis of NPCS and PPY@BDD
  - ✓ Synthesis of pyrrolic nitrogen doped porous carbon spheres
  - ✓ Modify various nitrogen contents
  - ✓ Optimization
  - ✓ Synthesize PPY@BDD
- ✓ Development of supercapacitor electrodes using carbon structures (hard carbons)
- ✓ Electrochemical Analysis
- ✓ Dissemination, Energy Storage Applications

1. Pyrrole Deposited Boron-Doped Diamond Electrodes

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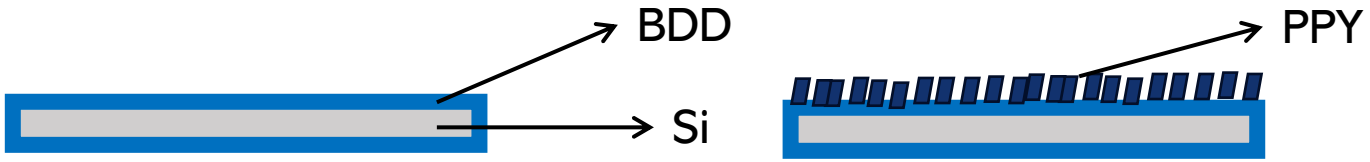
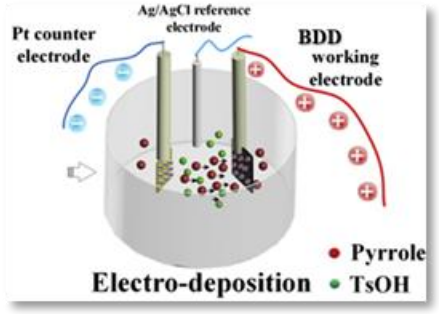


- The BDD films (~2 μm in thickness) were grown using hot filament chemical vapor deposition on **Si substrates** by addition of **trimethylboron** (10,000 ppm) to the H_2/CH_4 gas mixture. The surface morphology of as-grown diamond films reveals crystals with diameter of 600–900 nm.

- The surface of diamond film was further structured either by reactive **ion etching (RIE)** in oxygen based gas mixture (O_2 or CF_4/O_2) employing the gold nanoclusters as the masking material.

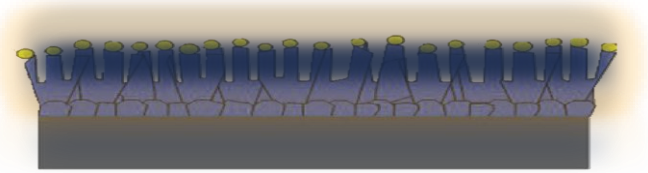
Poly pyrrole

p-toluenesulfonic acid



Drying

60°C, 6h



Electrochimica Acta 296 (2019) 617-626

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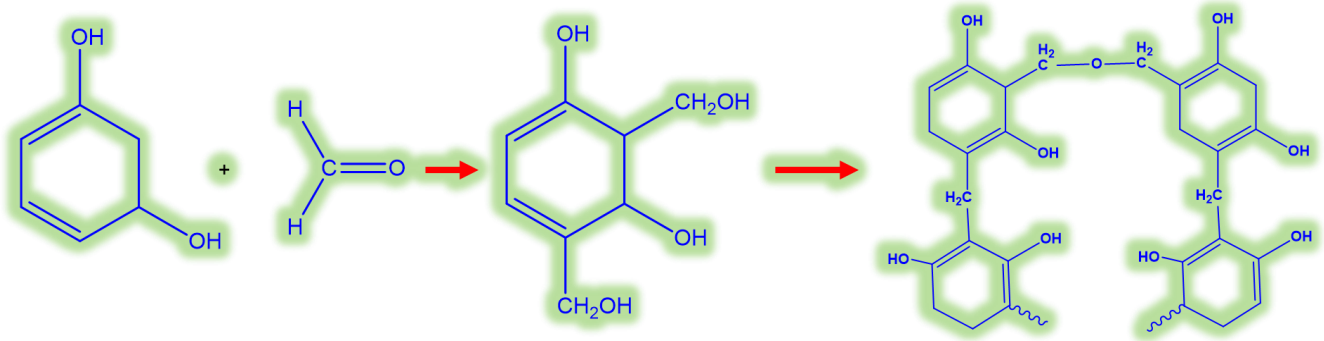
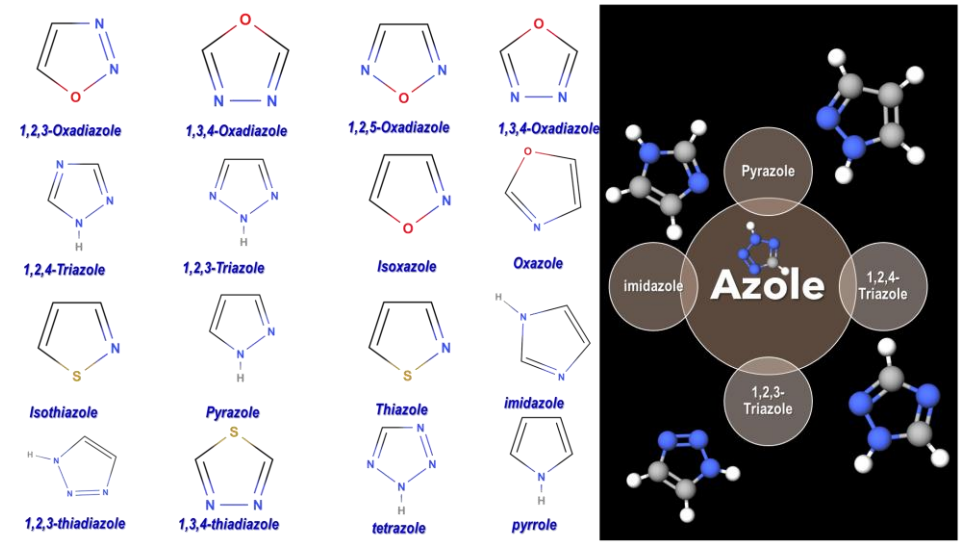
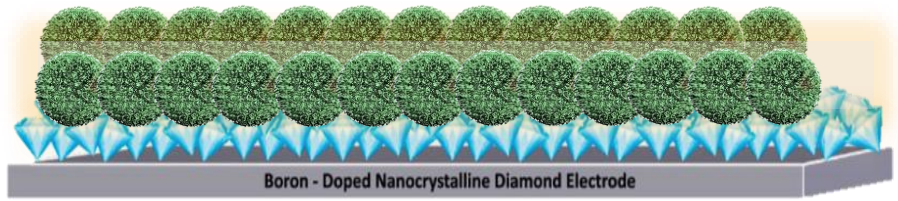
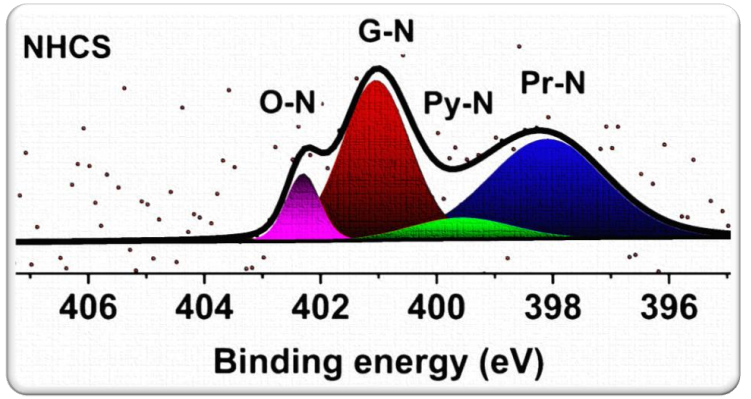
2. Synthesis of Hetero atom Doped Porous Carbon Structures

2. N-Doped Porous Carbon Structures









BDD will grown by microwave plasma **CVD**

R. Ranjithkumar et.al, Mater. Today Chem. 36 (2024) 101939.

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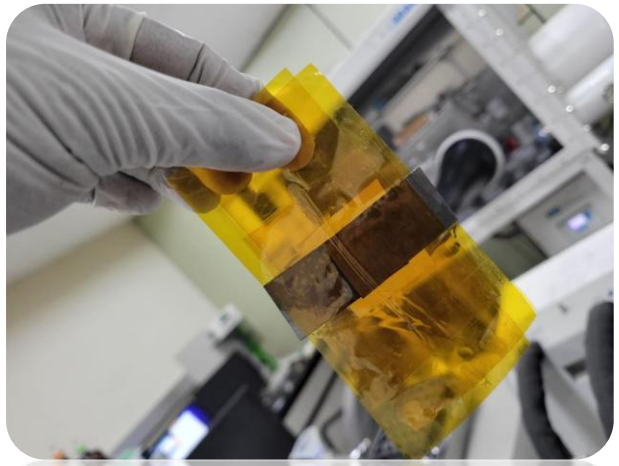
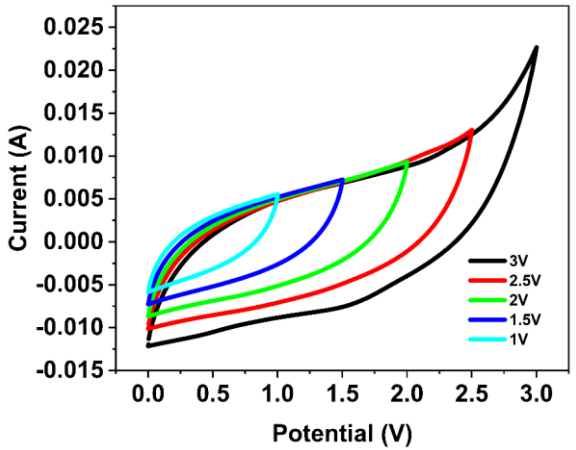
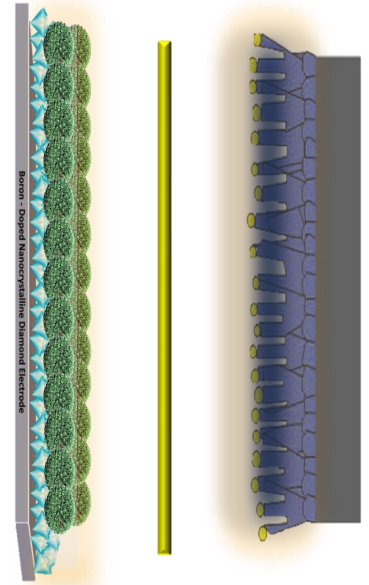
3. Device Fabrication



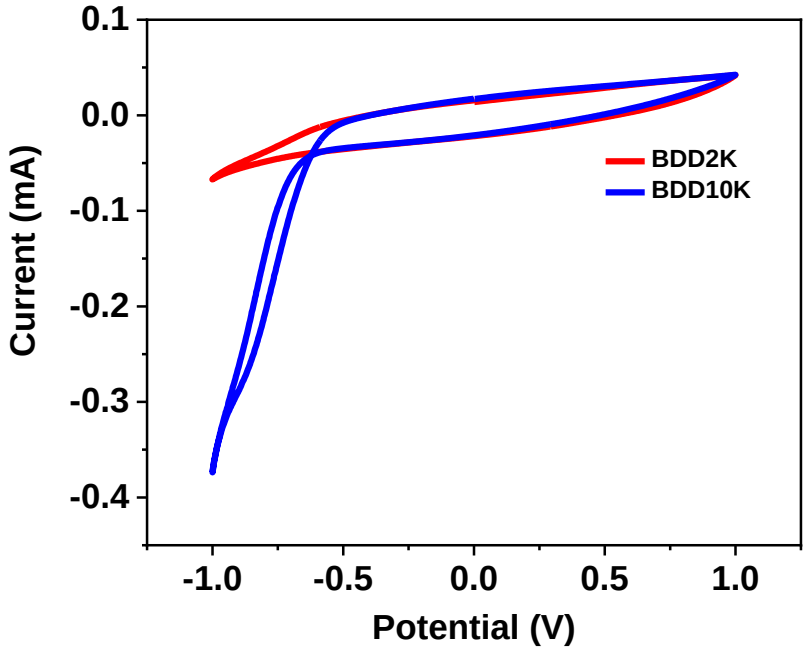


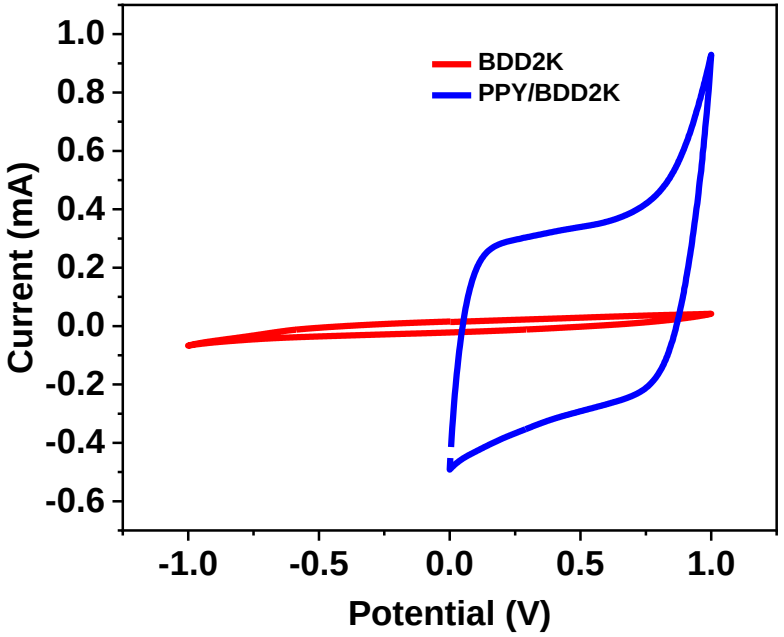


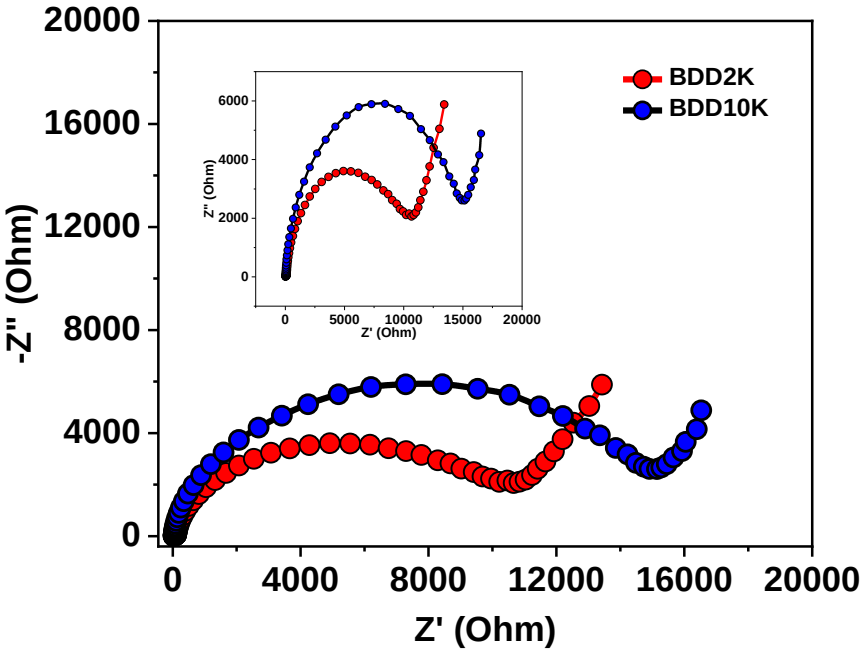
Electrochemical Analysis

- Cyclic Voltammetry
- Charge discharge profiles
- Electrochemical Impedance Spectroscopy
- Cyclic stability

4. Scientific highlights of the results







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Conclusion

Outcome of the project
• Maximizing **Hetero atom doping in carbon structure** • **Morphological, Size and porosity** controlling of NPCS • Diamond-polymer **hybrid electrode, understanding the interface**, charge transport at hetero structures • **Optimization** of BDD@PPy electrodes • High improvement in the **energy density** of the devices • Enhancement of the **cyclic stability** • **Fundamental research with possible outputs**

Diamond Growth Research Group

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Thank you for your attention

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Marie Skłodowska-Curie Actions – COFUND project, which is co-funded by the European Union (Physics for Future – Grant Agreement No. 101081515)

Co-funded by the European Union