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# Multifunctional thermostable oligomer based on para-phenylenediamine and resorcinol with hierarchical micro- and submicron structure

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## Abstract

*This work reports the synthesis and comprehensive characterization of semiconductive, π-conjugated oligomers based on 1,3-benzenediol (resorcinol) and p-phenylenediamine (PPD), obtained via oxidative polycondensation under ultrasonic irradiation in acidic medium, initiated by potassium persulfate and performed without surfactants. The synthesized materials were characterized by different physico-chemical methods. UV–Vis spectroscopy revealed distinct absorption bands corresponding to π–π* and n–π* transitions, indicating extended electronic delocalization along the conjugated oligomer backbone. Extrapolation of the linear region of the $(\alpha h\nu)^2$ versus photon energy ($h\nu$) plot yielded a direct optical band gap of 3.59 eV, confirming the wide-bandgap semiconducting nature of the synthesized material. FTIR, NMR, and elemental analyses confirmed the formation of co-oligomers with an approximate PPD-to-resorcinol ratio of 4:1. Thermogravimetric analysis demonstrated high thermal stability of the materials up to 550 °C. XRD analysis indicated a predominantly amorphous structure with a minor semicrystalline contribution. SEM imaging revealed that the co-oligomer exhibits hierarchical micro- and submicron particle sizes in the range of 0.1–3 μm. The surfactant-free co-oligomer pellets exhibited an average electrical conductivity of $7.94 \times 10^{-8}$ S·cm$^{-1}$. The broader ESR signal of the oligomer, exhibiting a mixed Lorentzian–Gaussian character, suggests more localized unpaired electrons and weaker exchange interactions compared to DPPH. The synthesized copolymers, obtained as black powdery materials, contain amine ($-NH_2$) and hydroxyl ($-OH$) functional groups and are soluble in*

*polar organic solvents.*

***Keywords:*** *conductive polymers; oxidative polymerization; para-phenylenediamine; potassium persulfate; thermogravimetric analysis*

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