Organic Electronics is one of the fastest growing technologies in the world. With the increasing development of molecular systems for electroluminescent devices like organic light emitting diodes and light-harvesting organic materials for photovoltaic applications, a number of challenges still remain to be overcome. Organic materials successfully compete with their inorganic equivalents, challenging them in terms of the possibility of tuning their optical properties, transparency, flexibility and what is important for commercial applications, the production cost. Looking for novel organic materials that would reveal better thermal stability, higher conductivity and the ability of charge storage, results in designing small molecular materials as well as polymeric compounds with parameters that are being continuously improved.

The objective of the research was to develop novel carbazole derivatives with different architecture which optical and electrochemical properties can be finely tuned. The choice of architecture was dictated by tailoring material’s optical properties – star-shaped architecture assisted by use of single bonds, facilitates synthesis of molecules with limited conjugation. Linear architecture, additionally equipped with double bonds favors elongated conjugation what translates to red shifted absorption and emission spectra. Materials have been designed in such a way to fulfil technological demands including thermal stability and solubility in common organic solvents. The research includes synthesis, characterization and application of novel oligomeric or polymeric materials that can be easily “p” or both “p” and “n” doped. The object of research were both low molecular weight compounds as well as oligomers and polymers obtained by electropolymerization of monomers comprising donor units only or both donor and acceptor ones. Investigated modifications include introduction of electron-donating or electron-accepting units (carbazole, thiophene, etylenedioxythiophene (EDOT), bithiophene, thienothiophene, terthiophene, triphenylamine, benzene and BODIPY), with different length of conjugation both in the core and in peripheral, what leads to shift of the absorption and fluorescence spectrum toward longer wavelengths and results in materials with different emission colours in the range of 400 to 700 nm.

The research methodology can be divided into two parts: synthetic and analytical. The first one includes organic synthesis of novel star-shaped/linear compounds. Monomers were obtained in multistep reactions sequence involving halogenation, alkylation, formylation, coupling (Stille, Suzuki) or condensation reactions. Synthesis was followed by purification of desired products by column chromatography and recrystallization. The obtained products were characterized using spectroscopic methods: $^1$H NMR, $^{13}$C NMR, ESI, MALDI TOF MS. Properties of the monomers were investigated using spectroscopic measurements (UV-Vis-NIR, fluorescence), electrochemical characteristic (inter alia the oxidation and reduction
potentials were examined using cyclic voltammetry, which enabled determination of the energy of HOMO and LUMO orbitals and the band-gap of the oligomers and their electropolymers), in-situ electron paramagnetic resonance and UV-Vis-NIR spectroelectrochemical studies which allowed to investigate the nature of appearing paramagnetic charge carriers as a result of electrochemical reactions. With the help of theoretical calculations, experimental data was used to explain the spectral features of the dyes as well as their electrochemical characteristics. Chosen materials were tested in optoelectronic devices: BHJ solar cells and luminescent solar concentrators.