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## Exploring the Opto electronic Properties of Polymers Containing Fluorene Moiety

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**Abstract** –The relationships between structure and photo-and electroluminescence and photovoltaic properties of fluorene containing polymer systems are addressed by systematic variation of chain composition and configuration.

A wide range of light emitting polymers bearing the fluorine unit is presented, encompassing two main structural configurations: PPV and PPP type. In the first the chromophores were linked through a double bond and in the other they were directly bonded. The interest in the polyfluorene family resides in the high intensity of the blue emission of the fluorene unit combined with its chemical and thermal stability. The possibility of inserting ramifications at the C9 position without altering the steric configuration of the polymer chain is another important feature, since it makes it possible to obtain soluble products from stiff backbone macromolecules.

The PPP type of polyfluorenes was prepared via the Suzuki condensation coupling: a bromide derivative of one moiety reacts with a boronic ester of the other. The Suzuki route leads to perfect alternated copolymers, and in that way structures containing phenylene, perfluorated phenylene, pyridine, and thiophene were synthesized.

The PPV type of polyfluorenes was synthesized via the Wittig reaction: a phosphine derivative of one comonomer reacts with a methyl bromide derivative of the other. Several alterations of the classic route were introduced in each specific case, to enhance solubility, enlarge molecular mass, and improve polymer yield, among others. The main examples of synthesized PPV type polyfluorenes include: copolymers with diyl vinylene units (counter part of PPV with fluorene); with alternated phenylene vinylene segments of various lengths; and copolymers with nitrogen containing comonomers such as pyridine, bipyridine and carbazole. The bipyridine structures were complexed with rare earths, with particular focus on Europium polymeric complexes for pure red hue emission. Several configurations of copolymers of fluorene with thiophene were also synthesized, with variation in the thiophene content and position in the backbone, to explore the effect of this good electron transporting group. In the majority of those systems the solubility was achieved by inserting lateral alkyl groups, mainly hexyl branches, but the concept of conjugation confinement was also applied. The introduction of inert spacers along the polymer chain, interspersed among the emitting groups, not only imparts solubility, as also adds other beneficial effects such as the improvement of film forming characteristics and the possibility to address the photophysical behavior of the isolated chromophore

Blends of poly(9,9-di-hexylfluorenediylvinylene-alt-1,4-phenylenevinylene) a very strong emitter with polyvinyl carbazole afforded light emitting devices (LEDs) with luminances above 12000 cd/m<sup>2</sup>, one of the highest published so far. RGB blends based on polyfluorene were used to produce white emitting devices. In some cases the cyano group was inserted into the double bond, via the Knoevenagel route, to improve electron injection and transport properties of the materials.

The relationships among structure and photo- and electroluminescence and more lately of photovoltaic properties of the very briefly above described polymer systems was addressed in terms of the emission performance of solution and film forms, LEDs and photocells behavior. The photophysics was strongly based in time resolved spectroscopy and the underlying morphology in each case was studied through epifluorescence (light emitting microscopy). The main effects operating in the emission mechanism can be roughly resumed as energy transfer, aggregation leading to ground state dimmers or excimers, phase separation, exciton trapping, among others.

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