Since the discovery and development of conductive polymers in the 1970s, which led to the award of the Nobel Prize in Chemistry 2000 to Alan J. Heeger, Alan G. MacDiarmid, and Hideki Shirakawa, an ever-increasing effort is being devoted to the science and technology of p-conjugated molecules and macromolecules. These systems display unique properties that make them appealing for a multitude of applications in optoelectronics, photonics, energy, and (bio)sensing. Compared to their inorganic counterparts, the greatest advantages of p-conjugated (macro)molecules lie in the molecular-level tunability of their optoelectronic properties and their processability into thin films through cheap and easily scalable methods. Further-more, macromolecular derivatives can feature mechanical properties (flexibility, toughness, malleability, elasticity, etc.) typical of plastics thus making it possible to fabricate nonplanar and even flexible yet robust devices.

The fabrication and technology of plastic optoelectronics is an area of intense international investigation where one of the ultimate goals is to develop smart and multifunctional devices such as LEDs, solar cells, field-effect transistors, and related applications in flexible active-matrix electronic-paper displays, sensing, and radionanoelectronics, and data-storage, as well as novel approaches to smart textiles, medical diagnostic tools (e.g. lab-on-a-chip), biocompatible devices (from artificial retinas to synthetical muscles), and flexible batteries.

At the basis of this interdisciplinary research endeavor, one can find the synthesis of more and more sophisticated 1D, 2D, and 3D (macro)molecular building blocks that are designed to exhibit specific physical and chemical properties. In particular, the synthesis of such systems that possess different structures and dimensionalities, as well as being characterized by multi-pie and regiospecific substitutions with functional groups at the core, in the scaffold and/or in the periphery, makes it possible to improve fundamental photophysical properties, namely excitation energy and electron transfer. This will allow, among others, tuning of absorption and emission properties, increases in thermal and (photo)chemical stability, enhancement of molar absorptivities and fluorescence quantum efficiencies, and generation of nonlinear optical responses.

It is widely established that the properties of organic and polymeric materials, either arranged as thin or thicker films, strongly depend on the organization at the supramolecular level. This means that the materials and device properties are determined not only by those intrinsic to the structure of the constituent molecules (molecular level) but also by those resulting from the interactions between adjacent molecules (supramolecular level). In particular, there are many physical properties, such as charge transfer (through hopping), charge split and recombination, and exciton diffusion, to name but a few, that depend more critically on the supramolecular organization. In light of this, the self-assembly and self-organization of macromolecules at surfaces and interfaces are key, also to enabling optimal interfacial properties such as charge injection and extraction via energy matching. Such a control over these physical properties at the molecular and supramolecular level is therefore of paramount importance for improved device performance.
This Special Issue highlights some of the most enlightening approaches on the synthesis of novel conjugated (macro)molecules with special properties arising from their p-conjugation, their processing and self-assembly at surfaces and interfaces, their multiscale analysis of the relevant physical and chemical properties, and their integration in optoelectronic, photovoltaics, batteries, and chemical sensing devices. Images from the Review and Minireview articles, as well as the paper featured on the cover are shown here.

We believe that this Special Issue will offer readers some inspiring examples of the wide scope of this field of science and technology and hopefully convey the enthusiasm of the scientists involved in this research. We are most grateful to all contributing authors for their effort in highlighting and addressing the key questions in this highly dynamic field of chemistry at its interface with physics and engineering, in the interdisciplinary realms of materials and nanoscience.

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