The construction of well-defined functional nanosized materials is of great industrial and scientific importance and represents nowadays an ever expanding topic. These materials may find application in different areas, from the development of efficient, cheaper and environmentally friendly optoelectronic devices to a whole new generation of catalysts, medicines, or selective membranes.

Despite traditional optical lithography and etching techniques used for micro- and nanofabrication (the so-called "*Top-Down*" approach) have shown an enormous development in recent years, they present several limitations that need to be addressed by other complementary techniques. First of all, they are impractical for structures smaller than 100 nm, since their resolution is limited by the wavelength of the light used and, in general, do not provide a fine control over the internal structure of the material at the nanometer scale. On the other hand, if smaller nanopatterns are required, the use of very expensive equipment and high-energy beams is then only limited to robust inorganic materials. There is a strong emerging need, however, to produce organic (*i.e.* plastic) materials with perfectly defined internal structure, composition, and function at the nanoscale. The advantages that organic materials can bring to society demands are manifold: they are cheap, easily processable, biocompatible, and can be endowed with very diverse functions and applications.

The natural world is a shining example when it comes to the utilization of organic materials. Nature has chosen the unlimited possibilities of organic molecules to produce a whole diversity of perfectly defined nanoobjects having particular functions. The way the molecules are organized into larger nanostructures in biological systems is by chemical recognition or *self-assembly*, whose importance and complexity represents a continuous inspiration to scientists in their quest for the construction of functional nanostructures through a "*Bottom-Up*" approach. We are entering a scientific period of "*complex matter*" in which the concepts and methodologies of supramolecular chemistry and self-assembly are meeting those of nanotechnology. The use of *functional organic molecules* and their organization *via* bio-inspired *self-assembly* represents a promising, challenging and extraordinarily versatile strategy for the future mass production of nanomaterials, nanodrugs and nanoelectronics.

However, controlling the shape and structure of self-assembled molecular systems continues to be a major challenge for scientists. For such a goal, one must "*program*" the molecular building blocks with the appropriate chemical information and be able to modulate the interplay between multiple noncovalent interactions, so that they work in concert to impart stability to the assemblies and, at the same time, define the overall architecture within the nanometer regime. If such nanoarchitectures are built from molecules with a particular function, one can expect unprecedented properties arising from cooperative interactions between them, which can be of extraordinary impact for several applied fields.

In this project we have used several concepts of supramolecular chemistry as a tool to organize π-conjugated molecules in a controlled way, in order to build well-defined, nanometer-sized functional objects. We have focused in π-conjugated molecules since we are highly interested in their function as active components in different emerging technological applications within the "organic/plastic electronics" field. This novel promising area has already yielded a whole family of plastic-based device prototypes, such as solar cells, light-emitting diodes, electronic displays or field-effect transistors. The main advantages of organic materials are manifold: they are cheap, flexible, easily processable, biocompatible, and can be modulated and endowed with very diverse functions. These appealing attributes indicate that, although currently producing relatively low performances, plastic optoelectronic devices have the potential to compete effectively with alternative inorganic technologies.

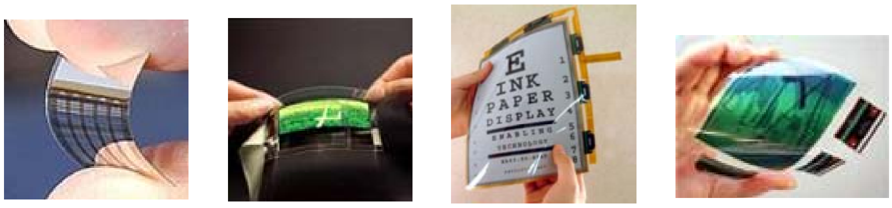

Figure 1. Emerging plastic optoelectronic technologies.

The major goal of our project is to determine the influence of the molecular organization and the morphology at the nanoscale on molecular interactions and, eventually, on the performance of organic-based devices. Concretely, we have focused our activities in phthalocyanine-like materials, which have been known for years as excellent molecular semiconductors and dyes. Our efforts were directed to synthesize Pc-like molecules that are able to aggregate by $\pi-\pi$ stacking and/or hydrogen bonding interactions forming nanowires or nanoparticles. The formation of columnar stacks of Pcs has been studied for years, but we have been particularly interested in investigating mechanistic aspects and trying to reach a control over the stack length, in order to have well-defined, uniform nanostructures.