# Electrochemical synthesis and characterization of conducting polymers

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The traditional understanding of polymers as excellent insulators was altered in the seventies of the last century when scientists succeeded in synthesizing polyacetylene with conductivity close to that of metals. This fact indicated a new property of polymeric materials and launched an entirely new multidisciplinary scientific field. Although sometimes the term "conductive polymers" encompasses a large group of compounds classified according to the nature of charge carriers, the term is most commonly used in the literature for polymeric materials from the group of so-called synthetic metals that possess electronic conductivity as a result of the specific molecular structure. In addition to the requirement of the molecular structure, which involves a conjugated system of double bonds, doping is necessary for the conductivity of conductive polymers. The term doping, although borrowed from the terminology of classical inorganic semiconductors, involves a significantly different process. Doping of conductive polymers involves oxidation (rarely reduction), during which, in order to maintain the electroneutrality of the polymeric chain, a stoichiometric amount of ions has to be introduced. Doping is also achievable by the involvement of acids such is the case of one of the most studied conducting polymers named polyaniline. By introducing such a large quantity of ions, the starting structure of the polymer is altered, and the properties of the resulting conductive material depend largely on the properties of the dopant. The presence of dopants is a key factor in electrochemical applications of conducting polymers since these ions can be almost reversibly doped/dedoped during the oxidation/reduction process. Although at the beginning of the development of this field, conductive polymers were synthesized by chemical methods, gaining insight into the mechanism of chemical synthesis which is oxidative radical polymerization, made it clear that these materials could also be obtained by electrochemical methods. Electrochemical synthesis has advantages, as the polymer is obtained by oxidation on the electrodes (anodes), avoiding the use of an oxidizing agent and enabling greater product purity. On the other hand, the conductive polymer is, in most cases, obtained in the form of a coating on the electrode, facilitating its further characterization by electrochemical techniques. The interest in the field of conductive polymer synthesis and applications especially in electrochemical technologies, remains strong, the topic of this lecture is dedicated to the basic principles of electrochemical synthesis and characterization with a special focus on the most popular conductive polymers, polyaniline and polypyrrole.