

Processing of Thin Films of Organic Semiconductors & Transparent Electrodes for Organic Electronic Devices Using Laser Techniques

The process of the surface of thin films of organic semiconductors and transparent electrodes by using laser techniques attracts more and more the interest the last years because of its advantages and its multiple applications. These techniques include a great number of processes like ablation of material, deposit of material and surface scribing. Of these techniques, we are more interested in techniques of scribing thin films by using visible and infrared laser radiation for the production of organic electronic devices and mainly for the production of organic Photovoltaics (OPVs). In theoretical part of this research paper, we describe the physics of the laser radiation, the properties of its beams, as well as the components of a device producing laser radiation. We referred to the existing types of lasers, as well as to the manner by which this kind of radiation is produced. Then, we described the properties of materials of organic semiconductors, which are scribed by laser radiation during the construction of organic Photovoltaics (OPVs), both, OPVs with normal structure and OPVs with inverted structure. Particular emphasis was given to the study of laser interaction with matter, during the laser scribing process. Laser interaction with matter is influenced to a great extent by the mechanisms of propagation and absorption of the energy of the laser radiation in the interior of the material of the thin films that are scribed. We also described and analyzed in details the three basic types of scribes (P1, P2 and P3), which are required to be conducted by using visible and infrared pulse laser radiation, during the manufacture of organic electronic devices. We also referred to and analyzed to some extent the basic parameters which affect the scribes of thin films created by pulse laser radiation. These parameters are the radiation flux, the wavelength, the pulse duration and the pulse repetition rate, the focus position of the beams, the polarization state of the radiation, the properties of the materials of the scribed thin films, as well as the environmental conditions of the space in which the scribes are conducted. In the experimental part of this research paper, we succeeded in finding the optimal experimental conditions (parameters), which lead to the formation of scribes of high quality in the surface of the thin films which form an organic Photovoltaic device (OPV). We studied and evaluated samples of scribed thin films of semi conductive polymers developed on substrates of PET. These samples were scribed by laser radiation with pulse duration of the order of ns, ps and fs. The scribes which were studied are mainly the type of P1 and P3 and they were examined by using optical microscope and scanning electron microscope (SEM). We conducted also the spectroscopic technique of energy dispersive X-ray (EDX) on some scribes in order to evaluate the extent of material removal in specific areas surrounding the scribes. This evaluation was based on the residual quantity (weight %) of the components of the materials which were detached during the conduct of the scribes. Finally, we made a short reference to the system which processes (thin films of organic semiconductors and transparent electrodes, using the roll to roll technique for the production of flexible, organic, electronic devices, as well as a reference to the integrated laser engraving system, which scribes the surface of thin films, by using laser radiation with pulses of ps.