Photoconductivity behavior and Stabilization of DA embedded in amorphous TiO_2 matrix synthesized by sol-gel method

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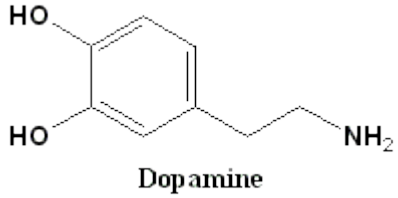
Parkinson's disease is a debilitating, often fatal, neurological disorder that affects about 1% of the population over 50 years of age. It is characterized by tremor in the extremities, difficulty initiating voluntary movements, and rigidity. It is well known that the Dopamine (DA) (Scheme 1) is an important neurotransmitter in mammalian central nervous system and low levels of DA have been found in patients with this disease [1]. It seems to be that the lost of DArgetic neurons in the substantia nigra is the primary cause of the Parkinson's disease [2].



Scheme 1. Molecular structure of DA.

Literature reports that DA is one of the major sources of reactive oxygen species (ROS) [3]. When exposed to the daylight, DA oxidizes very easy due to its chemical instability. DA contains an unstable catechol moiety with respect to its molecular structure; it can oxidize spontaneously in vitro, free radicals and quinones [4-6]. In addition, in the human substantia nigra, the oxidation products of DA may polymerize to form neuromelanin which may also be a highly cytotoxic substance [7]. Besides, a controlled release system to deliver the drug directly into the brain is of great interest for the treatment of the Parkinson's disease.

In this work, the synthesis of amorphous TiO_2 matrix by sol-gel method at room temperature in air atmosphere is reported. DA was encapsulated in two kinds of TiO_2 matrices to reduce its chemical instability. One sample is TiO_2/DA and the second one was synthesized by adding 15C5 to protect the DA from oxidation process. The stabilization process to avoid the oxidation of the DA was followed by absorption spectra (Figure 1) and infrared spectroscopy.

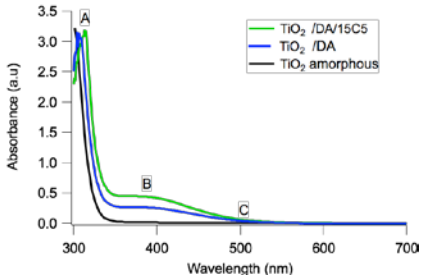


Figure. Absorption spectra of the TiO_2 /DA (blue line) and TiO_2 /DA/15C5 (green line) films. The spectrum for amorphous film corresponds to the black line.

Oxidation processes of the DA can be identified by the presence of DA quinone and DA chrome whose infrared bands are reported in the literature (Figure 2). The TiO_2/DA/15C5 shows more stability than the TiO_2/DA. For TiO_2/DA/15C5 sample, the oxidation process is retarded by one month approximately, while for TiO_2/DA this process is retarded only seven days.

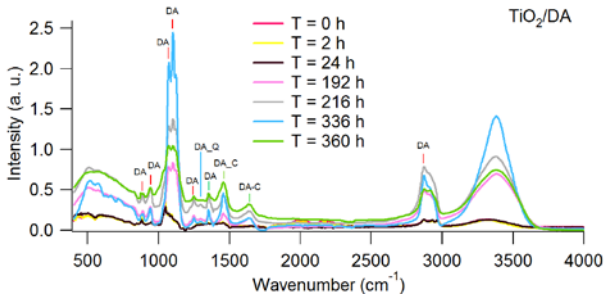


Figure 2. IR spectra for amorphous TiO_2/DA sample as KBr pellets.

Photoconductivity studies were performed on both kinds of films to analyze their charge transports. The experimental data were fitted with straight lines at darkness and under illumination at 320 nm, 400 nm, and 515 nm. This indicates an ohmic behavior. Transport parameters were calculated. The conductive effect is stronger under darkness than under illumination at 320 nm because the oxidation process in the darkness is less intense than under illumination. Besides, this effect is more intense in the TiO_2/DA film (Figure 3). A photovoltaic effect is stronger on TiO_2/DA/15C5 film than TiO_2/DA film.

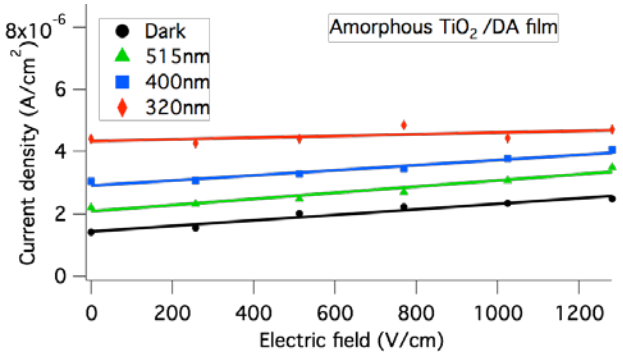


Figure 3. Current density vs. electric field spectra from amorphous TiO_2 /DA film.

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