Nanoscale ultraviolet and ozone degradation of P3OT films studied by Scanning Probe Microscopy.

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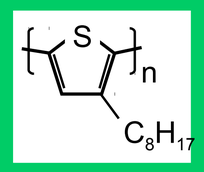
Introduction

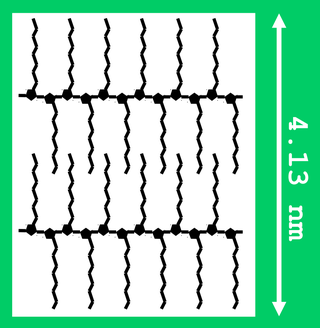
In the field of organic solar cells the power conversion efficiency and the durability are issues that have to be addressed before this technology is competitive with traditional silicon solar cells. To study the durability of plastic solar cells, in the present work we investigate the modification of thin P3OT films by ultraviolet (UV) radiation and ozone degradation. Films of about 100 nm thickness have been prepared by spin-coating on conducting as well as insulating substrates. The samples were analysed using Scanning Force Microscopy techniques (SFM) in particular Kelvin Probe Microscopy and local conductivity imaging and optical transmission measurements for every cycle of UV radiation and ozone exposure. Our experimental technique allowed us to perform a nanoscale study of the same area of the sample and therefore we can attribute the observed changes to the real effect of radiation as compared to possible statistical variations of surface properties.

The samples

10; 20; 40 mg/ml solution of P3OT in Toluene
Spin cast at 2500-4000 rpm
Substrates gold thin film and glass cover

Poly(3-octylthiophene)

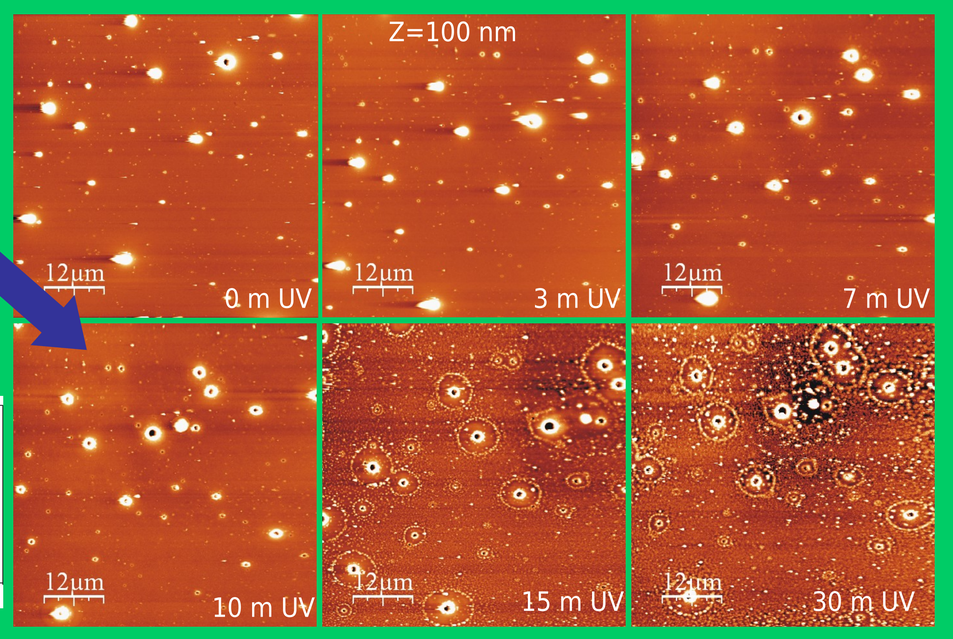




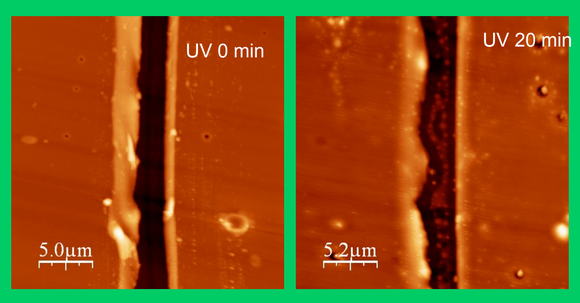
Large scale images

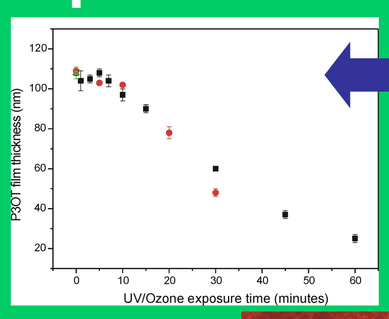
Main changes between 10-15 minutes located around the balls

Roughness



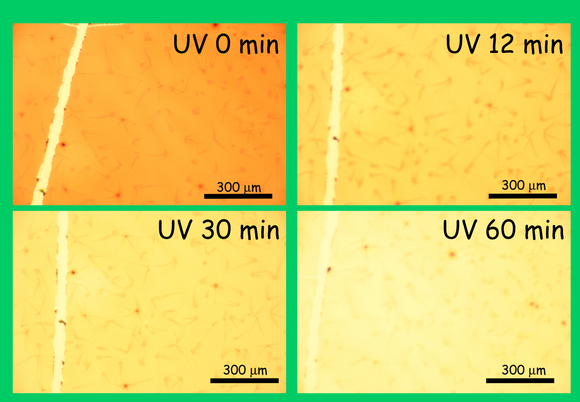
Thickness vs UV exposure

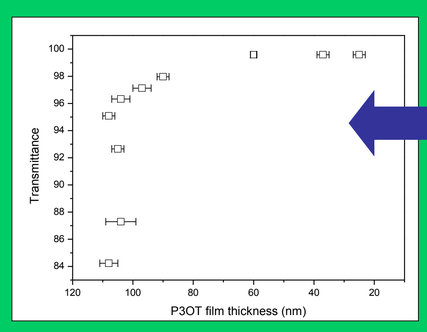




In the first 10 minutes of UV/ozone exposure the film thickness doesn't change

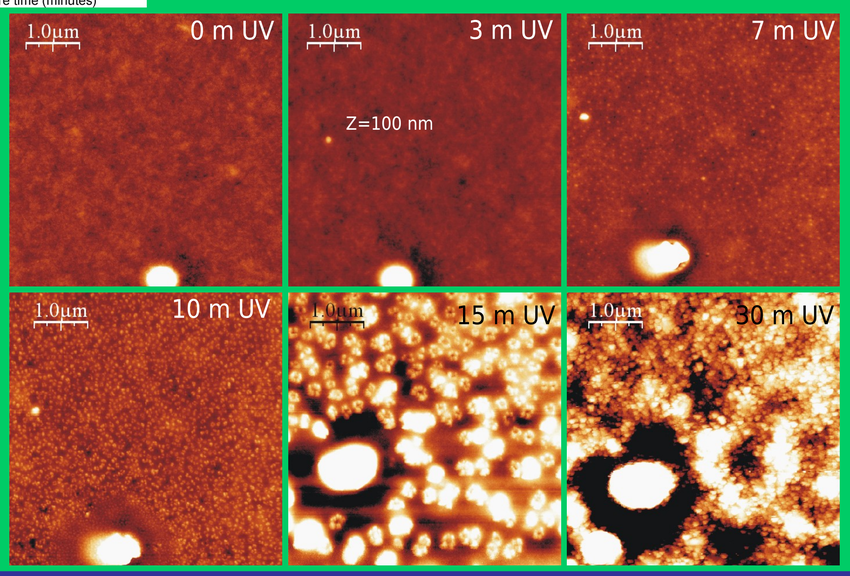
Optical measurements



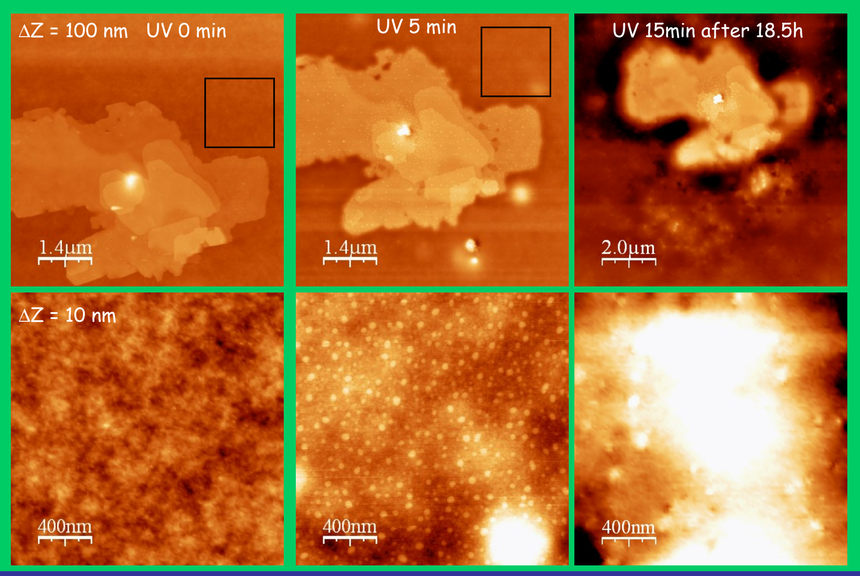


In the first 10 minutes of UV/ozone exposure the transmittance increase markedly

Small size images

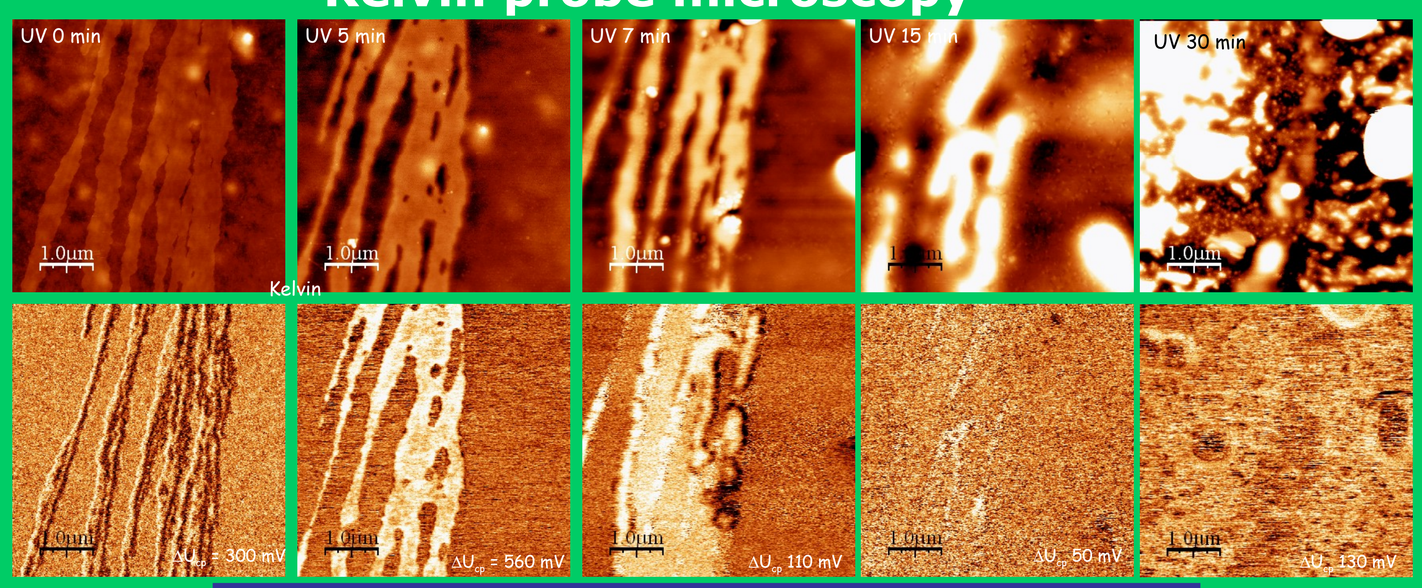


After 5-7 minutes small grain like structures appear



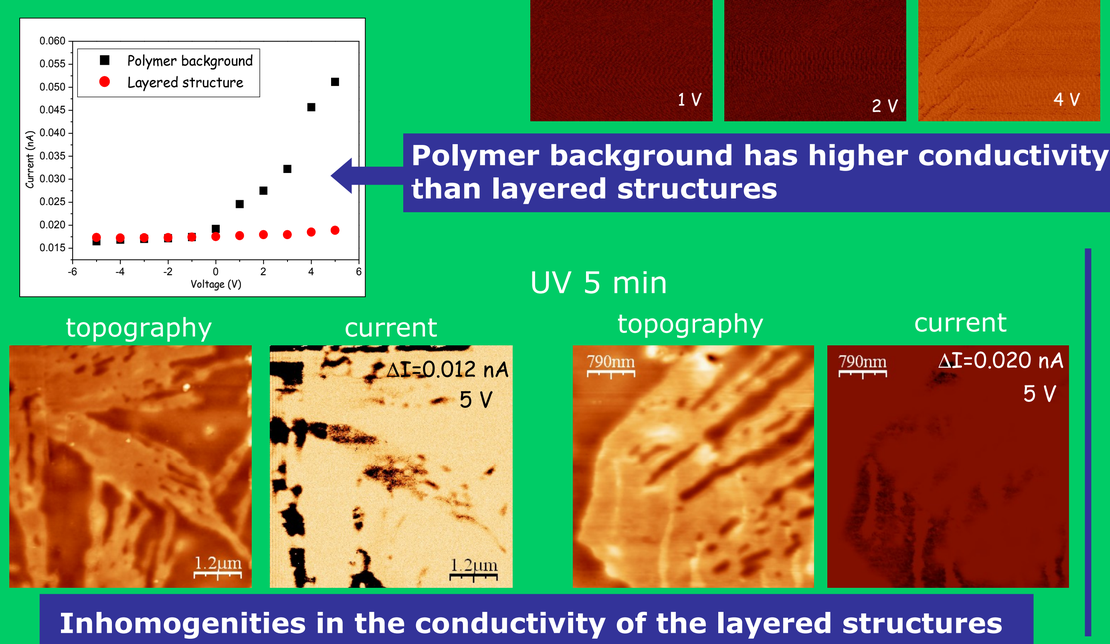
Layered structures are more resistant to the UV/ozone degradation than the polymer background

Kelvin probe microscopy



After the first UV/ozone exposure contrast of the images changes and the surface contact potential domains disappear

Nanoscale Current measurements



Polymer background has higher conductivity than layered structures

Inhomogenities in the conductivity of the layered structures

Conclusions

We have studied the effect of UV and Ozone exposure in the nanomorphology and electrical properties of P3OT thin films:

Homogeneous films with balls and layered structures. Increase of the roughness after 10 minutes of UV/ozone exposure

Different electrical conductivity is found between the polymer background and the layered structures. After UV irradiation appear inhomogenities in the conductivity of the layered structures

The jellyfishes are more resistant to the UV/ozone degradation than the polymer background

After the first UV/V exposure the contact potential contrast of the images changes and the surface contact potential domains disappear

Two regimes are found in the degradation in the first 10 minutes “chemical degradation” and after morphological degradation.