ROMA TRE
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RESONANT SOFT X-RAY REFLECTIVITY: A POWERFUL TOOL TO STUDY ORGANIC FILMS FOR MOLECULAR ELECTRONICS

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The performance of organic opto-electronic devices based on thin molecular films is determined by the structure and arrangement of the molecules at the nanoscale. The structure of semiconducting thin films is typically investigated by atomic probe techniques, which only give information on the outermost morphology, or by x-ray diffraction, which is useful only for systems presenting some degree of crystallinity.

Here, a powerful approach based on resonant soft x-ray reflectivity (RSXRR) is presented. RSXRR has demonstrated to be highly sensitive to the molecular orientation, film morphology, and electronic structure. In particular, we developed a protocol to get simultaneous quantitative information on the structure, interface morphology, chemical properties and optical anisotropies of layered organic materials with sub-nm depth resolution. The sampling depth is not limited to the near-surface region, as for electron spectroscopies. In addition, RSXRR is not affected by charging effects and it can be applied to insulating substrates, as in the case of most organic semiconductor devices.

A series of prototypical cases will be presented: 3,4,9,10-perylene-tetracarboxylic dianhydride (PTCDA) on Au(111), pentacene on SiO_2 (as in a realistic OTFT configuration), tetracene single crystal, Cu-phthalocyanine films.

The method transfers to the soft x-ray range the knowledge gained in the years in the field of visible and infrared spectroscopy of thin anisotropic films and offers a tool of quantitative investigation in those cases where electron spectroscopy cannot be applied due of the presence of nonconductive materials, poor vacuum or materials buried at distances from surfaces higher than the electron free collision path.