Severe Morphological Changes in Thin Films Deposited from the Spin-Crossover Complex Fe(phen)2(SCN)2

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The octahedral complex bis(1,10-phenanthroline)dithiocyanate iron(II), $Fe(phen)_2(SCN)_2$, is known to exhibit an abrupt transition between a high and low magnetic spin state near 175K. As a result, $Fe(phen)_2(SCN)_2$ is of interest to the study of spin-dependent electron transport in thin films. The synthesized $Fe(phen)_2(SCN)_2$ compound was characterized by UV-visible spectroscopy, attenuated total reflection infrared spectroscopy, powder x-ray diffraction, electrospray ionization mass spectrometry, and NMR. Thin films (~100-200 nm) of $Fe(phen)_2(SCN)_2$ were vapor deposited at about 225 ^{o}C onto a variety of substrates including, Al, Au, Si(100), and glass. When the films were exposed to air after removal from the vacuum chamber, severe morphological changes could be observed with the naked eye. Consequently the dynamics of the process were monitored by optical microscopy. Time-dependent optical images of the thin films taken immediately after exposure to air show mass transport propagation radially away from nucleation centers of unknown origin. When the morphological change is complete the initially smooth film has converted into macroscopically large islands .The dramatic morphological change can be retarded by storing the films in vacuum or a dry nitrogen/oxygen gas atmosphere. These control experiments suggest that adsorption of atmospheric water vapor is responsible for the phenomena. In order to gain further insight into the origin of the phase transformation we used x-ray photoelectron spectroscopy and IR spectroscopy to characterize the $Fe(phen)_2(SCN)_2$ thin films. Both methods suggest that one SCN ligand is lost during vapor deposition and/or film growth. The evidence to date suggests that upon exposure to air water molecules coordinate to the vacant ligand sites, which induces conformational changes in the local packing environment that eventually propagate through the film.