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Phase transition of copper (II) phthalocyanine thin films characterized by a near-field microwave microprobe

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Metal phthalocyanine is one of the promising organic compounds due to the possibility of applications in electro-optical devices, photoconducting agents, photovoltaic cell elements, nonlinear optics, electrocatalysis, and other photo-electronic devices. Several metal substituted phthalocyanines have been widely investigated. Among the metal substituted phthalocyanines, copper (II) phthalocyanine (Cu-Pc) has been found to have superior properties. Cu-Pc is a p-type semiconductor and mobility changes could be achieved by employing controlled substrate heating temperature during deposition. The crystal phase and the grain orientation of Cu-Pc depend on the heat-treatment temperatures and substrate heating conditions [1]. In order to better characterize the electrical properties of the α- and the β-phase of Cu-Pc thin films, we take advantage of the nondestructive evaluation capabilities of a near-field microwave microprobe (NFMM) [2]. NFMM techniques with high sensitivity have been developed for the microwave- and millimeter-wave ranges. An important ability of the NFMM is nondestructive and contactless characterization of thin films, in particular, the characterization of electrical properties of organic thin films. Organic multilayer thin films have attracted considerable interest in regard to various display applications. Nondestructive and contactless characterization techniques are very useful for these applications. NSMM technique, which directly measures the physical properties such as surface resistance of organic thin films shows practical promise.

To study the phase transition of Cu-Pc thin films, we measured the surface resistance using a NFMM by measuring the microwave reflection coefficient S_{11}. The crystal structure of Cu-Pc thin films transformed from the α-phase of the orthorhombic crystal to the thermally stable β-phase of the monoclinic crystal as the substrate heating temperatures increased. The surface resistance depended on the crystal structures of the Cu-Pc thin films. As the phase changed from the α-phase to the β-phase, the surface resistance of the Cu-Pc thin films decreased.

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Quantitative TEM analysis of structure and chemical composition of Si_{1-x}Gex islands

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(Si,Ge) is one of the model systems for investigating the self-organisation of nanostructures in semiconductor heteroepitaxy. The $Si_{1-x}Ge_x$ islands investigated were grown on (001) Si by liquid phase epitaxy (LPE) using different growth procedures. The transmission electron microscopical (TEM) investigations of plan-view as well as cross-section specimens were performed on a JEOL JEM2200 FS and a Philips CM 20 FEG both operating at 200 kV.

The size, shape and arrangement of the islands. were investigated by conventional TEM (diffraction contrast method). A combination of high-resolution imaging (HRTEM) and methods of quantitative HRTEM (qHRTEM) like DALI [1] and the Geometric Phase Method [2] were applied to determine strain and chemical composition of the island system. In order to differentiate between Ge and Si, particularly in the interface region, high-angle annular dark-field (HAADF) scanning TEM (STEM) Z-contrast imaging was used at atomic resolution.

To reveal the microchemistry of the layer/island system combined STEM and energy-dispersive X-ray spectroscopy (EDXS), electron energy loss spectroscopy (EELS), as well as energy-filtered TEM (three-window technique) were performed. In general, a higher Ge concentration was found in the upper island regions compared to that in the island ́s base using the different analytical techniques.

The results obtained will be critically discussed concerning both the methods applied and the growth conditions of the epitaxial system.

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