Abstract

It has been predicted that the properties of the new material, carbon phosphide may be interesting from an electronic and optoelectronic point of view. This study is concerned with synthesising carbon phosphide, and analysing its properties. In this study Radio Frequency Plasma Enhanced Chemical Vapour Deposition (RFCVD) and Liquid Phase Pulsed Laser Ablation (LP-PLA) were used to produce carbon phosphide.

In RFCVD CH_4/PH_3 gas mixtures were used to make thin amorphous films containing C and P. The P:C ratio varied linearly with P content in the gas mixture. Films with a P:C ratio of up to 3:1 were grown. These films still contained an estimated 10% of hydrogen and a small amount of oxygen. SIMS studies showed that most of the O and H was on the surface and that the films had a uniform composition beneath the surface. An increase in the P content in the film decreased the band gap in a linear fashion from 2.4 – 2.2 eV.

By varying the ion energy it was found that the P:C ratio decreased with increasing ion energy, but SIMS revealed that the bonding between C and P increased with increasing ion energy. It is suggested that this is due to the preferential sputtering of loosely bonded P species and that the increased energy of the incoming species caused more bonds to be formed. The band gap decreased in a linear fashion from 2.6 – 2.3 eV. It was also found that films deposited at higher ion energies had only trace amounts of H and O in them. It is thought that this is due to the preferential sputtering of loosely bound H and better O resistance due to more CP bonding.

By varying the substrate temperature it was found that the CP bonding increased with increasing substrate temperature. The films deposited at elevated substrate temperatures were found to be highly oxidised. It was found that the band gap of these films increased from 2.2 – 3.6 eV with increasing temperature.

Using LP-PLA with graphite as the solid and water or cyclohexane as the liquid it was found that nanocrystalline diamond was formed. This result showed that LP-PLA is similar to a high pressure, high temperature technique. From this information the synthesis of carbon phosphide was attempted with carbon-containing liquids and red phosphorus and graphite mixtures. Several crystals were found by TEM that had crystal structures similar to those predicted by theory.