Novel, Liquid Precursors for PECVD

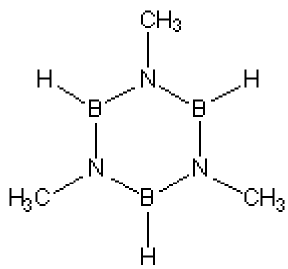
In this work, we test the use of two liquid precursors: Trimethylborazine (TMBz) and Hexamethyldisiloxane (HMDSO) for deposition of p-type doped layers by a Radio Frequency Plasma Enhanced Chemical Vapor Deposition process. These two liquid precursors are easier to handle compared to gaseous precursors and present an opportunity to reduce risks in the photovoltaic fabrication facilities.

TMBz was used for the p-type doping of hydrogenated microcrystalline silicon (p-µc-Si:H). The layers were examined using optical and electrical characterisation techniques, as well as Secondary Ion Mass Spectrometry (SIMS) and Fourier Transform Infrared (FT-IR) Spectroscopy Dark conductivities of the order of 10^{-2} S/cm were achieved at optimised deposition conditions for the p-µc-Si:H layers. These p-type layers were tested in single junction hydrogenated amorphous silicon p-i-n solar cells and an initial efficiency of 4.9 % was achieved.

HMDSO was used as silicon and oxygen source for the deposition of p-type hydrogenated microcrystalline silicon oxide (p-µc-SiO_x:H) layers. Materials studies show that the refractive indices of the layers can be tuned over the range from 2.5 to 3.9 (measured at 600 nm) and in-plane dark conductivities over the range from 10^{-8} S/cm to 1 S/cm, suggesting that these doped layers are suitable for solar cell applications. The most conductive p-type layers were tested in single junction amorphous silicon p-i-n type solar cells and an initial efficiency of 5.5 % was achieved.

HMDSO was also used a silicon and oxygen source for the deposition of p-type silicon oxide (p-SiO_x) dielectric layers as a boron diffusion source in crystalline silicon (c-Si) substrates. The p-SiO_x layers were characterised before and after thermal diffusion by Spectroscopic Ellipsometry, FT-IR and SIMS. We find that there is a reduction in thickness of p-SiO_x layer after thermal diffusion and boron is diffused inside the n-type c-Si substrate, forming a p^+ layer. The concentration of active carriers (generated from boron) was measured by Electro-chemical Capacitance Voltage technique and sheet resistance of the order of 120 Ω/sq was obtained. The obtained properties of p^+ layers were used in PC1D simulations and a theoretical efficiency of 20.1% (p-type c-Si solar cells) and 18.2 % (n-type c-Si solar cells) was demonstrated.

Keywords: liquid precursors, safety, trimethylborazine, hexamethyldisiloxane, silicon solar cells



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H
N
H
B
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N
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H3C
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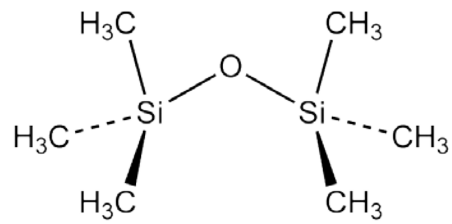
CH3
H



H3C
CH3
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H3C
Si
Si
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H3C
CH3