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Effect of pressure on the chemical composition and structure of carbon nitride film deposited by RF magnetron sputtering

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Research on carbon nitride thin films has been primarily driven by the desire to synthesize the superhard β-C_3N_4 phase predicted theoretically. Many attempts have been made to synthesize this material by both physical and chemical methods, but there is few evidences of β-C_3N_4 phase. In this study carbon nitride films have been deposited using RF magnetron sputtering at different pressure and gas ratio. The influence of gas pressure on the growth mechanism and chemical structure of the carbon nitride films has been discussed. The composition and bond structure was analyzed by Fourier transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). The film growth rate was increased with increasing total working pressure and nitrogen proportion in the sputtering gas. However, film growth rate was decreased when the working pressure was over ~10 mTorr. The nitrogen contents of films were in the range of 39-47%, increased with working pressure. The result from FTIR analyses showed that the amount of sp3 C-C or sp3 C-N bond increased with increasing working pressure while the number of the sp2 hybridized carbon bonds decreased. According to the first-principle calculations, the increase of sp3 carbon bonds can be explained by sp2 carbon bond dissociations caused by cross-linkage between graphene layers due to N incorporation. XPS revealed that the increment of sp3 C-N bonds were more prominent than that of sp2 C=N bonds applying working pressure of more than 10 mTorr.