Influences of deposition condition on atomic scale friction of amorphous carbon thin film

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INTRODUCTIONS

In decade years, many researchers have studied about hydrogenated amorphous carbon (a-C:H) film. Because of advantage of their characteristic such as a chemical inertness, optical transparency, good thermal conductor and high mechanical hardness[1]. Especially, the atomic scale friction behavior of a-C:H thin film, deposited by ECRCVD (Electron Cyclotron Resonance Chemical Vapor Deposition), is influenced by their unique chemical composition, and low surface roughness. Also, Unlike diamond, which is a crystal of pure carbon with sp^3 bonding, a-C:H films consist of small isolated sp^2 bonded clusters embedded in a partially hydrogenated random network of sp^3 coordinated carbon.[2] The role of hydrogen on surface of a-C:H film has influence on their mechanical property and structure and the hydrogenated form of a-C:H thin films appears to have reached a maturity in understanding of its properties.[1] As already noted, the structure of a-C:H thin film has the unique chemical composition with sp^2 and sp^3 bonding is necessary to understand atomic scale friction behaviors.

EXPERIMENTAL

a-C:H thin films were deposited using ECRCVD consisted of two chambers, a plasma generation chamber and a reaction chamber. Microwaves with 2.45 GHz frequency were introduced into the plasma generation chamber through a quartz bell jar. The substrates employed were B-doped p-type Si (100) wafer cleaned method of RCA. The a-C:H film was deposited at a pressure below 5×10^{-7} Torr. CH_4 gas was used as a carbon source gas and H2 gas was used as a precursor gas. Deposition is performed at a total pressure of varied from 7 to 38mTorr with CH_4 and H_2. The microwave power during the deposition was maintained at 500W. The CH_4/H_2 gas flow ratio was varied from 0.5 to 40.0, and the deposition temperature was R.T. After deposition perform in situ thermal treatment from 100 to 400℃. Fourier transform infrared (FTIR) spectroscopy was analysed to obtain bonding characteristics and determine sp^3 and sp^2 concentration ratios. Atomic scale friction behavior is analysed by lateral force microscopy (LFM) mode using micro-centilever. Hydrogen and carbon concentrations of a-C:H films were studied by X-ray photoelectron spectroscopy (XPS) and Rutherford backscattering spectrometer (RBS). Hydrogen concentration on surface of the a-C:H thin films is determined by RBS data simulation method.

RESULTS AND DISCUSSIONS

The mechanical and atomic scale frictional properties of hydrogenated amorphous carbon thin film is influenced with deposition condition. The different deposition condition of the a-C:H thin films have the different deconvolution of C-H stretch region and super-low roughness by thermal treatment temperature and gas flow ratio. Atomic scale friction also have different force according to sp^3/sp^2 ratios. Therefore, atomic scale friction behavior is influenced on roughness and structure of the a-C:H thin film according to the different deposition conditions.

REFERENCES

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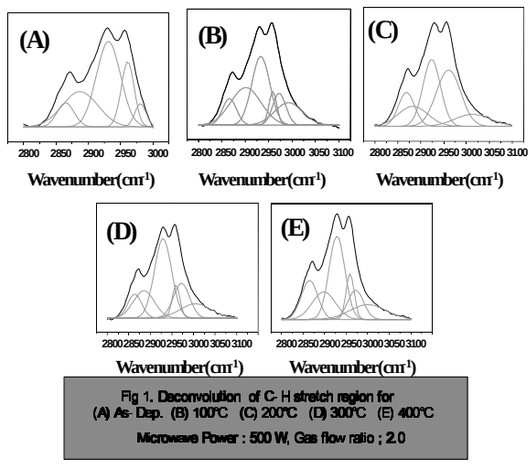

Fig 1. Deconvolution of C-H stretch region for (A) As-Dep. (B) 100℃ (C) 200℃ (D) 300℃ (E) 400℃
Microwave Power : 500 W, Gas flow ratio ; 2.0

Peak region contribution

	(A) As-Dep.	(B) 100℃	(C) 200℃	(D) 300℃	(E) 400℃
3085	0	0	0	0	0
3035	0	14	10	16	15
2990-3000	5	10	30	17	13
2975	17	7	0	8	13
2955	43	32	5	0	0
2920	0	0	29	37	32
2920	0	0	0	0	0
2885	27	29	13	11	13
2855	8	8	13	11	14
SP_3 / SP_2	0.78	0.69	0.60	0.59	0.59

Table 1. Peak region cotribution for (A) As-Dep. (B) 100℃ (C) 200℃ (D) 300℃ (E) 400℃
Microwave Power : 500 W, Gas flow ratio ; 2.0