Temporal evolution of fragment ions of methylsilane and dimethylsilane generated in tungsten-based Cat-CVD processes

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Ionic fragmentation in Catalytic Chemical Vapor Deposition (Cat-CVD, which is also known as Hot Wire CVD) processes is studied with a use of a low-energy mass analyzed ion beam system, in which the mass and energy distributions of fragment ions produced from methylsilane or dimethylsilane in a chamber with a hot tungsten wire (i.e., catalyzer) are measured. The mass analysis shows that dominant fragment ions from methylsilane are typically H_1^+, H_2^+, H_3^+, CH_3^+, SiH^+, and $SiCH_4^+$. In the case of dimethylsilane, dominant fragment ions are H_1^+, H_2^+, CH_3^+, Si^+, SiH_3^+, $SiCH_4^+$, SiC_2H^+, and $SiC_2H_7^+$. It is found that in both cases the energy distributions of these ions are narrow and no energetic ions are produced, which indicates that, in actual methylsilane or dimethylsilane Cat-CVD processes, the produced ions are unlikely to cause any significant damage to the deposited films. The ion production rates are also found to be strongly dependent on the catalyzer temperature. In addition, the temporal evolution of these fragment ions are also measured. When the catalyzer temperature is less than 1960℃, the intensity of these fragment ions are decreased rapidly. About 30 minutes after the start of the experiment, no fragment ions are observed. On the contrary, when the catalyzer temperature is more than 2000℃, the intensity of these fragment ions decreases only gradually. Even 6 hours after the start of the experiment, we can observe the fragment ions whose intensity is more than half of that at the start of the experiment. The decrease of the ion production rate in the low temperature case seems to be related with the modification of the tungsten wire surface during the process. The x-ray diffraction and x-ray photoelectron spectroscopic measurements showed that silicon carbide, carbon, and tungsten carbide compounds were formed on the tungsten wire surface during the process.