Influence of Molecular Weight of Organic Contaminants upon Adsorption Behaviors onto Silicon Surfaces

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The organic contaminants on wafer substrate surfaces cause many detrimental effects such as electrical property degradation, yield losses, and etc [1]. As the process temperature for giga scale integrated device manufacturing is reduced more and more, the importance of organic contaminants removal becomes even more important [2].

Fig.1 shows the amount of organic contaminants adsorbed on Si surface during exposure in clean room, which was determined by a thermal desorption and gas chromatography–mass spectrometry (GC-MS). Compared to the reference wafer: no exposure wafer surface, many kinds of contaminants on the surfaces are deposited by the clean room air.

Fig.2 compares the amount of adsorbed organic contaminants with varying molecular weight (Mw) of aliphatic hydrocarbons. It is worthwhile to note that the amount of contaminants less than C14 (denotes $C_{14}H_{30}$) and or more than C28 is very small, but it has maximum value between the C18 and the C20. In general, the vapor pressure decreases with the increase of the Mw, so that, the amount of adsorbed contaminants is proportional to the Mw. Therefore, it remains unclear why the amounts at C20 and above are decreased.

Fig.3 is showing a schematic diagram in our study, which was fabricated in order to investigate the adsorption energy from Si surface with the Mw. The inner surface of stainless tubing line was directly passivated by the Si film that was deposited at 450°C for 48 hrs using 100 ppm SiH_4 in Ar gas ambiance. The contaminants are first generated from organic compound vaporizer using Ar purging gas. Following, the experimental conditions are adjusted in the sample tube. And then, the amount of organic contaminants on the surface is made by an atmospheric pressure ionization mass spectrometer (APIMS) system.

Fig.4 represent the dependence of the C14 adsorption properties on the flowing time. The temperature increase leads to rapid saturation of the gas concentration on the surface. The adsorption behaviors on Si surface are same irrespective of the Mw difference. Fig.5 shows the adsorption energy of various organic contaminants calculated from the data of fig 4. The energy increases with the increase of the Mw of contaminants. Judging from our data, the amount of the adsorbed contaminants with the Mw can be determined by the relationship between the vapor pressure of contaminants and adsorption energy onto Si surface, not vapor pressure only of the organics.

Fig. 6 is the model of adsorption behaviors of various organics onto wafer surface. The contaminants with small Mw are not adsorbed on the surface. This is due to high vapor pressure of the organic contaminants. In case of the contaminants with large Mw, the adsorbed amount is also decreased. This is attributed to adsorptopn energy increase, though the vapor pressure decreases with the increase of the Mw, so that, the contaminants are not adsorbed on the surfaces. Based on our results, we will propose a material selection method to minimize organic contamination in clean room.

Reference

[1] T.Iwamoto and T.Ohmi,Appl.Surf.Sci.,**117**,237(1997).
[2] T.Ohmi, J.Electrochem. Soc., **143**,2957(1996).

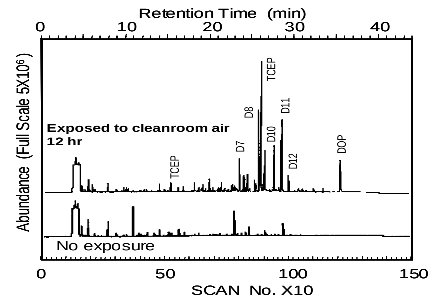

Fig.1 Organic contaminants adsorbed on Si wafer during exposure in the clean room.

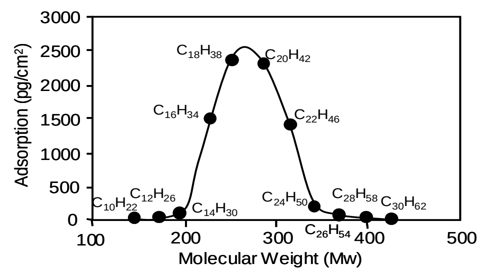

Fig.2 The amount of organic contaminants with varying molecular weight of aliphatic hydrocarbons.

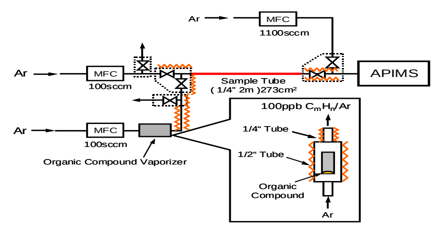

Fig.3 The schematic diagram for activation energy of organic contaminants on Si surface.

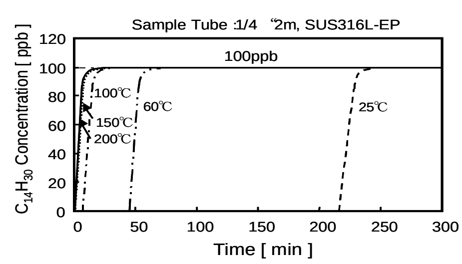

Fig.4 The adsorption behaviors of $C_{14}H_{30}$ on Si surface.

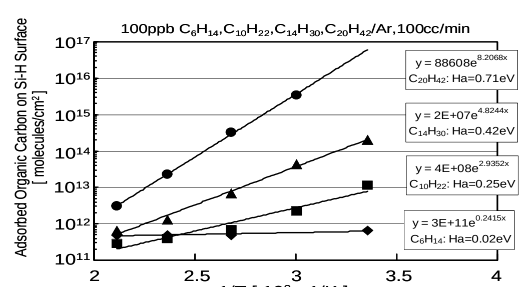

Fig.5 The adsorption energy of various organic contaminants.

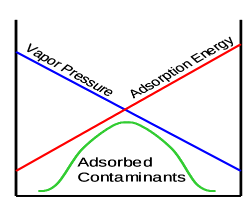

Fig.6 The model of adsorption behaviors of various organics onto wafer surface.