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The Role of Surface Hydride and Fluoride in Low-Temperature Si CVD (Application of *in-situ* FTIR Technique)

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Nowadays, many efforts have been made to lower the growth temperature in the silicon deposition. As the deposition temperature is lowered, defect formation becomes extremely sensitive to oxidizers and surface imperfection.

We grew crystalline silicon film on silicon substrate by CVD using SiH_2F_2 in the feed at temperatures as low as 250℃. The film was characterized by Raman, FTIR, and XRD.

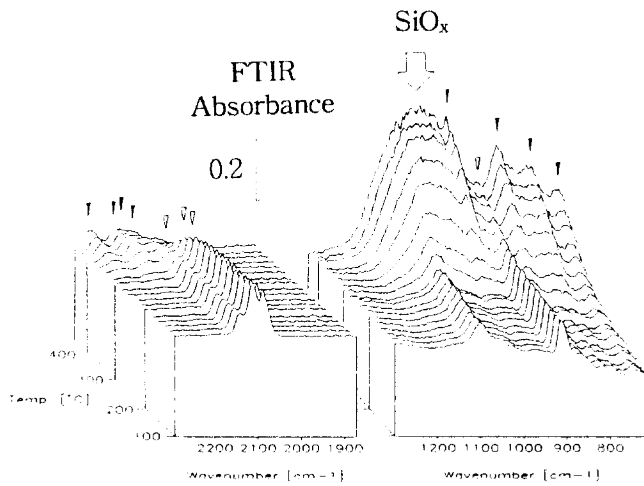
Our study was focused on the role of adsorbed hydrogen and fluorine in the CVD process. Porous silicon film prepared by electrochemical anodization was used as a high-surface-area sample for the film deposition and for *in-situ* FTIR observation of the film surface at elevated temperatures. We attempted to estimate the surface populations of chemicals during the film growth by rapid pump down followed by temperature-programmed FTIR.

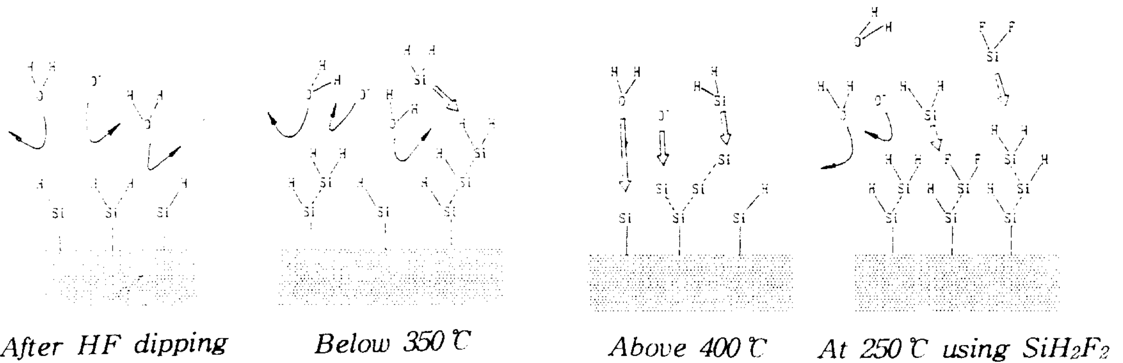
Figure shows that IR peaks near $910cm^{-1}$ and $2100cm^{-1}$ corresponding to the surface hydrides disappear above 350℃, which is accompanied by appearance of new peaks near $1100cm^{-1}$ and $2200cm^{-1}$ representing the surface oxide and fluorinated oxide species respectively.

The results indicate that the surface hydrides protect the silicon surface from oxidation until they are desorbed at temperatures above 350°C. SiH_2F_2 decomposes at lower temperatures than SiH_4 does and therefore is advantageous over SiH_4 for CVD at low temperatures. However, the hydrides were almost replaced by the fluorides when the feed for the CVD contained SiH_2F_2 and the process temperature was above 400℃. The silicon surface was etched because the fluorides combined with themselves to produce gaseous silicon fluorides.

When the process temperature was lowered to 250°C, the surface was not etched but allowed growth of a highly crystalline silicon film. The surface was covered with both the hydride and the fluoride species, and therefore the fluoride combination was retarded. Nevertheless, the fluorides enhanced the film growth by removing the excess amounts of the hydrides at low temperatures. This role of the fluorides was in addition to those of the hydrides mentioned above.

The third role of the proper amount of hydrides is to enhance the surface migration of the film precursors, thus improving the film crystallinity.





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