A new type of hydro-fluorinated a-Si (a-Si:F:H) is formed by glow-discharged decomposition of SiF\textsubscript{2} and H\textsubscript{2} mixture. SiF\textsubscript{2} is intermediate active gas, and is produced from SiF\textsubscript{4} gas and solid Si by the reaction; SiF\textsubscript{4} + Si $\rightarrow$ 2SiF\textsubscript{2}. This paper is to show that this new a-Si:F:H is photo-conductive as highly as the conventional hydrogenated a-Si (a-Si:H) even for the sample formed at relatively high deposition rate and it is heat-resistant up to the temperature more than at least 500°C for annealing in vacuum. This is also to show that impurity-diffusion constant in this film is smaller than that in a-Si:H by several orders of magnitude.

The film deposition system is schematically shown in Fig.1. SiF\textsubscript{4} gas is flowed through solid Si pieces heated at 1150°C, and 50 to 90% of SiF\textsubscript{4} gas is chemically converted to SiF\textsubscript{2}. The SiF\textsubscript{2} gas is immediately mixed with H\textsubscript{2} and introduced into a glass tube for plasma deposition. The flow-rate of SiF\textsubscript{2} was kept at 10 sccm, that is, the net flow-rate of SiF\textsubscript{2} was 10 sccm or more. The flow-rate of H\textsubscript{2} was varied from 0 to 150 sccm. The gas pressure P\textsubscript{g} during deposition was 0.1 Torr and the rf power 25 to 30 W. The substrate temperature T\textsubscript{s} was varied from 250 to 550°C, but mainly kept at 500°C.

One of advantages to use SiF\textsubscript{2} gas as a F source is that the a-Si:F:H can be grown under any plasma conditions, although the condition for deposition by SiF\textsubscript{4} and H\textsubscript{2} mixture appears limited. The film growth rate was monotonically increased with increase of H\textsubscript{2} flow-rate and reached to the values from 5 to 10 Å/sec for H\textsubscript{2} flow-rate more than 100 sccm. The photo-conductivity $\Delta\sigma\textsubscript{p}$ was also increased with increase of H\textsubscript{2} flow-rate and reached to $10^{-6}$ or $10^{-5}$ (Å cm)$^{-1}$ for the exposure of 1 mW/cm\textsuperscript{2} He-Ne laser, as shown in Fig.2. The photo-sensitivity, a ratio of $\Delta\sigma\textsubscript{p}$ to dark-conductivity $\sigma\textsubscript{d}$, approached to $10^4$ under the same light. This means that the a-Si:F:H is photo-conductive as highly as the conventional a-Si:H in spite of relatively high deposition rate.

According to nuclear reaction and Rutherford backscattering experiment, F content was almost constant and about 5 atomic % but H content was increased with increase of H\textsubscript{2} flow-rate. For instance, it was about 7 atomic % for the sample deposited at T\textsubscript{s}=500°C and at H\textsubscript{2} flow-rate of 120 sccm. The H content is not so low. However, as shown in Fig.3, no degradation of $\Delta\sigma\textsubscript{p}$ and photo-sensitivity was observed even after annealing in vacuum at the temperature over 500°C for the.
Finally, the diffusivity of Sb in our film was studied from the change of Sb profile due to annealing, because the impurity diffusion was considered to be one of key factors to decide the life time of a-Si devices. The Sb profile was observed by the Rutherford backscattering method. Figure 4 shows the Sb profiles in both a-Si:H and our a-Si:F:H, and also shows their change after annealing at 400 °C for 5 hours in dry N₂. It is apparently found that the diffusivity of Sb in our film is lower than that in a-Si:H. The diffusion constant of Sb in the a-Si:F:H was estimated smaller than that in a-Si:H by several orders of magnitude.

In conclusion, so far, the following are obtained; 1) a-Si:F:H produced from SiF₂ and H₂ gas mixture is photo-conductive as highly as a-Si:H, in spite of relatively high deposition rate, 2) it is heat-resistant up to the temperature more than 500 °C at least for annealing in vacuum and for the sample deposited at Tₜ=500 °C, and 3) impurity-diffusion constant in this a-Si:F:H appears to be smaller than that in a-Si:H by several orders of magnitude.