A. Description of dry etching mechanism by fluorine gas
B. Reasons why fluorine gas is **essential** in the dry etching mechanism with fluorine gas
C. Reason why substitution is **not possible** for gases other than fluorine gas (other halogens) (For example, differences in boiling point, selectivity, and anisotropy in SiF4 and SiBr)
D. Explanation of the above from the viewpoint of both dry etching gas and cleaning gas

E. Current status of disposal
(exclusion rate data)

The following is an excerpt from "SIA PFAS Consortium.pdf".
"Some etching processes use PFAS as primary gas(es), whist others use PFAS as an additive. Each of
achieved, therefore many different combinations of PFAS are used."
"Plasma etching is directional, making it possible to target the specific, microscopic features needed t
anisotropic/isotropic etching and protective layer formation can be obtained by using plasma of PFAS
indispensable steps in the production of semiconductor devices."
"In the semiconductor industry today, very high aspect ratios are required to enable increasingly dem
out smaller and smaller gaps. Especially where etching the insulator of the semiconductor device stru
etching, when controlling the dissociation ratio of PFAS molecular radicals by plasma. By using directi
or otherwise altered during the etching process, using a deposited layer consisting of C and F, it is po

With the increase in calculation speed and storage capacity, semiconductor devices are required to b
depth.

The amount of the target material to be etched is mostly a silicon-based material, and radical species
a hole deeper, the compound produced by the reaction between silicon and the radical must be elimi
most of the holes are dug by etching using F and Cl radicals whose products are easily vaporized.

When digging a hole deeply, the precision of the shape of the hole is required, and it is necessary to p
decomposed by the plasma must be polymerized on the surface of the substrate, and the protective f
fluorine-based materials. Protective membranes also protect against physical damage from ions. Fluo
protection, so replacing this mechanism is quite a challenge.

Especially in the etching of silicon oxide (SiO2), which is an insulating film, CF-based gases are very in
SiO2 film and forming reaction products with high vapor pressure (reaction model: $SiO_2 + CF_4 \rightarrow SiF_4\uparrow$

Explained in B. In addition, since the Si substrate is processed, the existence of the Si compound duri
semiconductor.

However, when SiO2-based reaction products are attached to parts in the chamber, PFAS gas may re
Therefore, it is considered possible to reduce the amount used compared with NF3 gas. After cleaning
and since PFAS gas is used at this time, PFAS gas is essential for cleaning. SiF4 may also be used, but

The IPCC has established formulas and coefficients for calculating fluorine gas emissions, which are ca
the decontamination equipment (*), it has been confirmed that the decontamination effect is greater
gas released into the atmosphere is small, and the introduction of the decontamination equipment is

*Example: CF4 exclusion rate: default 89% based on IPCC2019Tier2c ⇒ monitoring results 99% or hig