Plasma Charging Damage Performance Assessment with Scaled-up Process From 200 mm To 300 mm Dielectric Etch Chambers

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Plasma induced device damage performance is a key parameter to evaluate the maturity of 300mm plasma etch chamber. Especially the directly scaled-up recipes from 200mm to 300mm enable direct process performance transfer possibility thus process development time can be reduced. However, it is difficult to acquire 300mm device wafers to validate direct device plasma charging damage performance during 300mm etch chamber and process development. In this paper, we present the methods to predict the future 300mm etch chamber plasma damage performance indirectly by Contact Potential Difference (CPD) and the DC bias pick-up measurement on 200mm and 300mm eMax dielectric etch chambers as shown in Fig.1.

CPD uses blanket thermal oxide wafer to measure surface residue charge after plasma exposure. The measured surface voltage can be used to relate to device damage. Because CPD is sensitive to surface oxide loss, it can only be used on process selective to oxide such as resist ashing and nitride spacer overetch. Table 1 shows the CPD results from 200mm chamber with different resist ashing splits and scaled up process splits in 300mm chamber. From device damage data of 200mm wafers, high pressure (500mT) and high power (500W) splits show device damage, which corresponds well to CPD results. In 300mm CPD results, only the high pressure split shows similar trends of plasma damage. The spacer over-etch CPD comparison between 200mm and 300mm also show the similar trend.

DC Bias pickup measures the plasma V_{dc} bias on top of the process kit as shown in Fig. 2. Although the measured V_{dc} may not be the same as on the wafer, the difference between the max to min (ΔV_{dc}) can relate to the B-field response and device damage. Fig, 3 compares the measured ΔV_{dc} between 200mm via etch process and the scaled-up via etch process in 300mm chamber. As B-field increases, the ΔV_{dc} increases responding to strong B-field corner effect at the top of process kit Similar ΔV_{dc} response with different CMF B-field strength is observed between 200mm and 300mm chamber. Because 200mm device wafers have passed plasma damage spec with 30G recipe, it is expected that the 300mm 30G via etch should have the same plasma damage performance.

In summary, the scaled-up process in 300mm eMax chamber show similar trend of plasma damage in terms of CPD and the DC pick up measurements compared to 200mm eMax chamber.

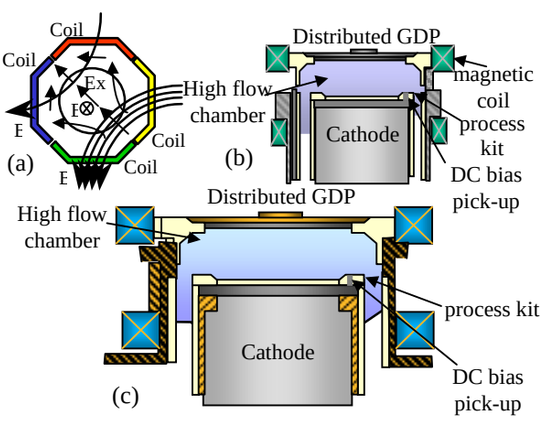

Figure 1 Schematic diagram of (a) configurable magnetic field (CMF), (b) 200mm eMax and (c) 300mm eMax dielectric etch chambers.

Table 1 V_{pdm} data from Contact potential difference (CPD) measurements of different directional resist ashing splits in 200mm and 300mm eMax chambers with scaled-up process.

200mm V_{pdm}	80mT 300W	80mT 100W	80mT 500W	30mT 300W	500mT 300W
Avg	2.12	2.19	2.50	2.15	**6.13**
Std	0.50	0.548	0.629	0.212	2.69
Min	1.10	1.06	1.46	1.82	0.902
Max	2.92	3.01	**10.8**	2.87	**10.4**
300mm V_{pdm}	80mT 675W	80mT 225W	80mT 1125W	30mT 675W	500mT 675W
Avg	1.39	2.44	1.59	1.16	**5.76**
Std	1.57	1.55	1.36	0.97	1.02
Min	-2.80	-1.60	-2.24	-2.56	1.50
Max	3.73	4.70	3.29	2.30	**7.40**

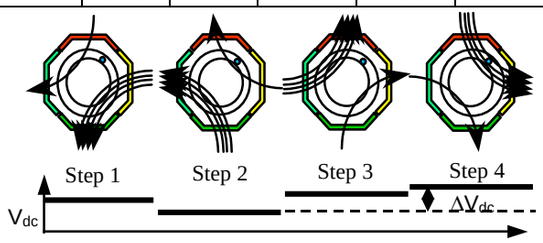

Figure 2. V_{dc} time evolution measured from fixed point DC pickup with different stages of configurable magnetic field (CMF).

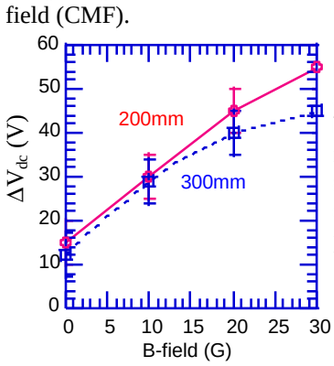

Figure 3 ΔV_{dc} of via etch process measured by DC bias pick up measurement in 200mm and 300mm eMax chamber with scaled-up process.