AXIC APPLICATION REPORT

PLASMA DEPROCESSING FOR FAILURE ANALYSIS 15

DEPROCESSING IN PLASMA for failure analysis requires the selective removal of materials such as silicon nitride, silicon dioxide, Ti and W silicides, metals and other materials. Because of the requirement for selective delayering, usually a wet chemical etching is applied. However, it does not provide sufficient control of removal rate and due to the isotropic nature of chemical interaction it may undercut the portion of the structure to be analyzed and destroy it.

Removal of pasivation and functional layers may be successfully accomplished in the plasma environment implementing RIE mode of operation with the Multimode HF-8 plasma system. It provides reproducible results, reasonable etching rate and selectivity, good anisotropy without undercutting the device structure. Also it offers process control by several parameters such as RF power, reactor pressure, gas composition and plasma-surface chemistry. The role of these parameters is described in Table 1.

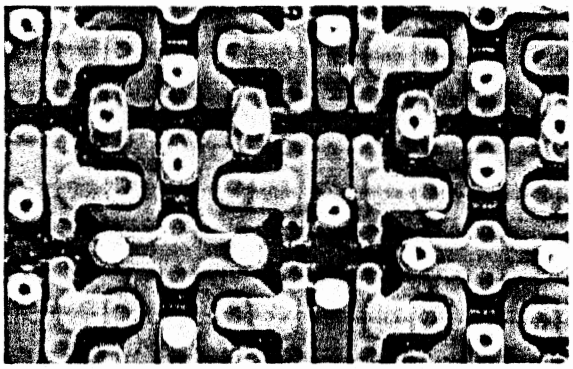
These parameters give the ability to control the dc bias voltage at the substrate electrode, that plays an important role in damage elimination due to electrical charging and sputter contamination. The dependence of self DC bias developed in HF-8 system is shown on Fig. 1. In reduction of contamination, which almost produces so called "RIE grass", the gas composition plays the key role. The CF_4 : CHF_3 ratio as process parameter in dependence on RF power and resulting process effect onto the structure are illustrated in Fig. 2.

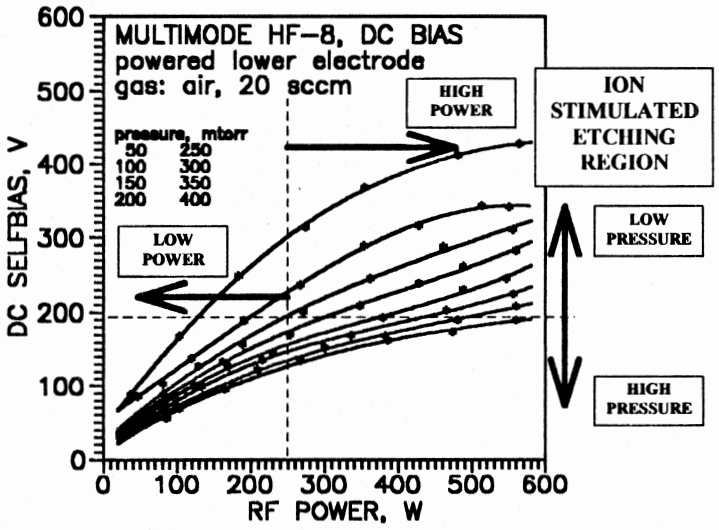
By controlling the etchant gas composition and total pressure in conjuction with the the dc bias voltage (rf power) an excellent anisotropic etching results are produced with absence of RIE grass and excessive side wall polymerization.

TABLE 1 **Process parameters influence on the etching and/or polymerization conditions.**

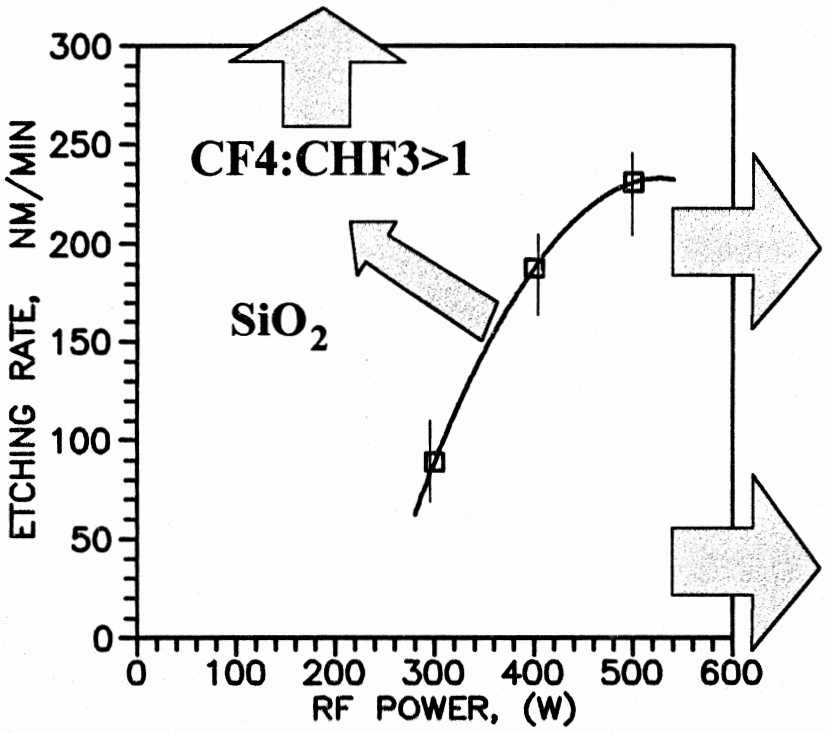
Si-BASED MATERIALS ETCHING	DC bias selectivity control for etching	
	REDUCED ION BOMBARDMENT	**INDUCED ION BOMBARDMENT**
GAS ENVIRONMENT	**at HF-8 conditions:** • **low power (< 250W)** • **high pressure (> 300 mtorr)** • **ground or floating electrode**	**at HF-8 conditions:** • **high power (> 250W)** • **low pressure (< 300 mtorr)** • **powered electrode**
CF_4	**etching**	**etching**
CHF_3	**polymerization**	**etching**
CHF_3 + CF_4	**selectivity control from polymerization to etching of material**	

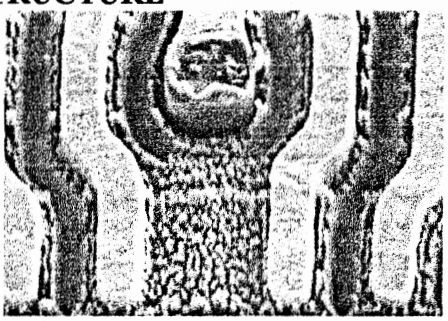
Fig. 1
The DC bias vs. RF power dependence at pressures in the range from 50 to 400 mtorr (MULTIMODE HF-8). Flow rate - 20 sccm, RF powered stainless steel water-cooled electrode.



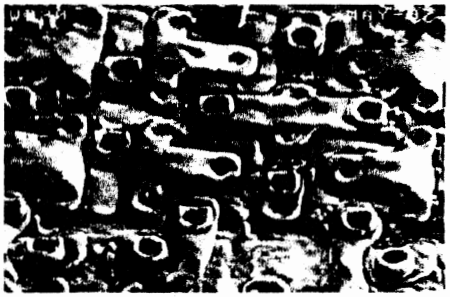


DEPROCESSED STRUCTURE





RIE GRASS



POLYMER FORMATION

Fig. 2: Dependence of etching rate of th. SiO_2 on RF power in CF_4/CHF_3 (200/100 mtorr, total 255 mtorr).

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