AXIC APPLICATION REPORT

IMPROVEMENT OF WETTABILITY OF GOLD SURFACE BY PLASMA TREATMENT

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PLASMA is widely used in IC fabrication for processing of various dielectric, organic and metallic materials. Moreover, it can be used also in other branches for achievement and modification of properties such ***as wetting, dyeing, printing and adhesion*** [1].

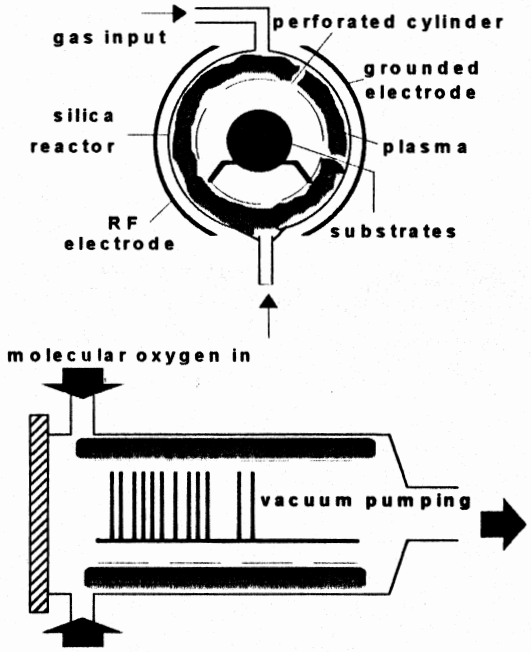

FIG. 1
Typical cylindrical (or barrel) configuration of capacitively excited plasma reactor.

The plasma pretreatment in an oxygen/inert gas plasma may influence aftergoing chemical processes [2]. Generally, the samples pretreated in an oxygen (and/or inert gas) plasma are exhibiting higher wettability in water and chemical solutions.

Various configurations are used for plasma treatment of surfaces. Often, the reactor with parallel plate electrodes is used, it provides high process uniformity due to good thermal contact between wafers and electrode and protects overheating of samples. Placement of samples on grounded electrode may reduce the ion bombardment. However, electrodeless plasmas are used to reduce to a minimum physical sputtering of the sample. Ion bombardment is avoided in reactors with a Faraday cup - Fig. 1, downstream (or afterglow) reactors. Non-toxic gas mixtures ($Ar+N_2+O_2$) are used for plasma treatment. The operating pressures are in range 0.4 - 7 torr. Radio frequency or microwave plasma are involved at moderate power level (~200 W).

The products of AXIC (Santa Clara, California [8]) cover most of used electrode and reactor configurations for mentioned applications. One of the simplest but more powerful system is the MultiMode HF-8, which can serve both for parallel plate, cylindrical or stray configuration. Typical barrel system is on Fig. 2.

The pretreatment of samples in O_2/Ar plasma [3] may serve as an example of wettability improvement of gold surface properties (gold on Kapton or ceramic substrate materials) when using the MultiMode HF-8. We have

demonstrated highly improved results on wetting of polymeric surfaces when using the plasma system in Fig. 3.

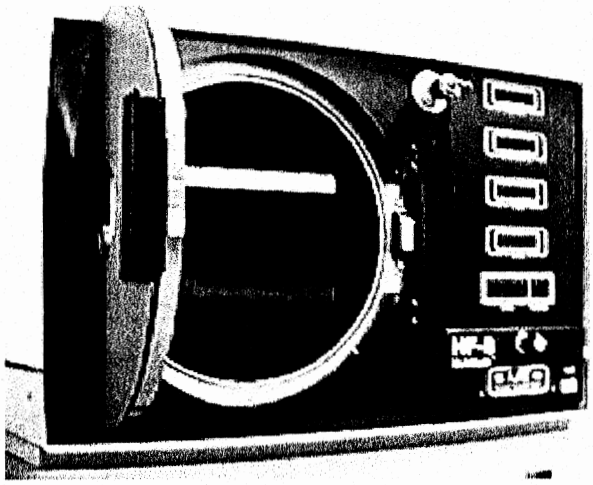

FIG. 2
Barrel plasma reactor with planar electrode configuration.

Samples were processed in the Multimode HF-8 (13.56 MHz) with planar electrode setup using a typical process such as: the upper electrode powered at 150-200 W, electrode at room temperature, pressure of gas mixture (argon and oxygen) is usually in a range 700-1000 mtorr.

Upon the requirement, higher pressures can be employed, (in our opinion optimal pressure for given process may be set up to 2 torr). From the point of view of process conditions and parameters, there is no significant difference in chemistry and physical parameters in use of 800 mtorr or 1.5 torr. Typical plasma treatment time is 3 min. The contact angle as a measure of wettability by distilled water may be measured before and after plasma cleaning using, for example, the NRL contact angle goniometer (Rame-Hart, Inc.).

The wettability properties of plasma treated samples (gold on Kapton foil) can be characterized by the change of contact angle from 42.4°±2.3° (before) to 7.1°±0.9° (after), and other samples (gold on ceramic substrate) from 76.5°±1.4° (before) to 5.1°±2.2° (after).

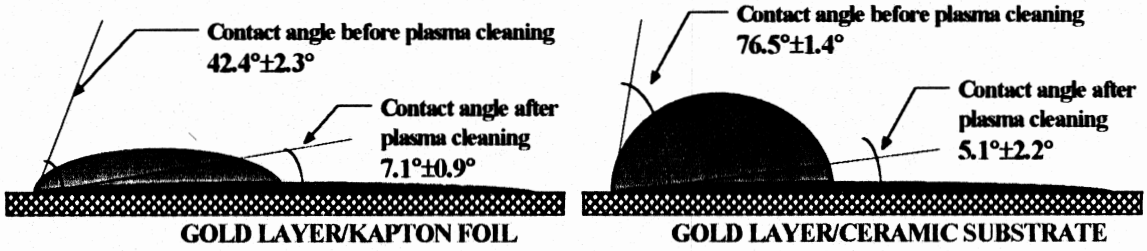

FIG. 3
Variation in contact angle (distilled water) before and after plasma cleaning: (a) gold layer on Kapton foil, treated in MULTIMODE HF-8, (b) gold layer on ceramic substrate treated in BENCHMARK-800.

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[2] **Brcka, J., Breza, J. and Harman, R., *Investigation of the surface contamination after/before selected technological steps*, in: *The VI. Symp. on Element. Processes and Chemical Reactions in Low-temperature plasma*, Jelšava - Hrádok, Czechoslovakia (June 9-13, 1986).**

[3] **Brcka, J., *Plasma Treatment of Surfaces, in: Plasma Application Report*, AXIC, Santa Clara, CA (1996).**