High Radical Flux, with Low Ion and Photon Flux, Plasma Source, for MEM'S technology

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Abstract:

Micro-electromechanical system (MEMS) are main constituent of a variety of sensors, that include pressure and vibration sensors, accelerometers and gyroscopes, and radiation and temperature sensors. MEMS is a technology that could answer the IoT's requirements for sensors high sensitivity.

To be able to produce MEMS with lower cost and higher quality, different steps are necessary with preventive treatment, like substrate cleaning or sacrificial photoresist removal, with plasma.

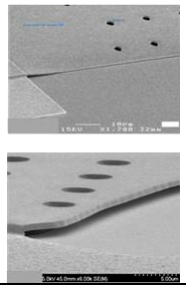
In this work, we introduce a unique inductively coupled downstream plasma source configuration to generate high density radical concentration, for a chemical action and surface activation, but without high ion and photon fluxes, in opposition with conventional inductively coupled plasmas.

Our plasma technology provides a unique process capability for ultimate surface preparation, removal of most difficult residues formed during semiconductor and MEMS processing. System features an innovative approach to "Inductive Coupling", introducing a proprietary plasma confinement technology that is capable of a quasi-full gas dissociation inside the discharge tube, at low RF power. Although the plasma discharge tubes are isolated from the treatment chamber, with a remote plasma design, they deliver a large concentration of free radicals. That "High Density Radical Flux" technology (HDRF®) has demonstrated concentration levels up to 1,000 times higher than conventional plasma sources. HDRF® provides a damage free processing, allowing cleaning of high aspect ratio structures, preventing collapsing or stiction free of membranes, and activation of ultra-sensitive materials, that could be find in MEMS technology. Most of applications include Bosch polymer removal, low temperature photoresist stripping, descum and activation of ultrasensitive surfaces prior to bonding, like MEMS capsuling or shielding.

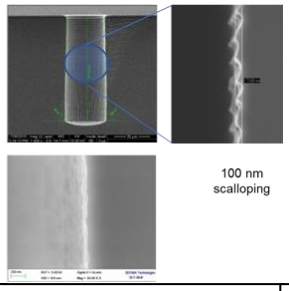
The low ion and photon exposure significantly reduces the opportunity for damage to sensitive layers. This inductive plasma arrangement prevents local heating and charging on the wafer. With that low local electrical potential, the HDRF® is efficient with 3D structures on the wafer (e.g. MEMS and other high AR features) where preventing ion shielding effects is important.

This work will first describe the **HDRF®** source and different advantages for MEMS processing. Second, several applications using the HDRF® technology will be discussed. These applications will include cleaning of 30:1 aspect ratio (AR) silicon vias, removal of sacrificial layers in MEMS structures, low temperature photoresist removal, and surface smoothing of Bosch generated sidewalls using micro-isotropic etching.

1) Odyssey PlasmaTherm's tool with HDRF technology



2) MEMS treatment without and with HDRF



3) Bosch process polymer removal with HDRF

4) Surface activation and PR removal on Sapphire wafer at low temperature