PECVD Nitride

PECVD Nitride allows a faster deposition, which therefore allows thicker layers. Stoichiometry and stress can be adjusted. Edge coverage is good and etch rates are comparatively high. PECVD nitride is very suitable for passivation layers. Usually, silane and ammonia are used as feedstock. Deposition can take place at temperatures below 400°C.

$3\,SiH_4 + 4\,NH_3 = Si_3N_4 + 24\,H_2$

PECVD deposition systems

Tension, stress

Due to different lattic spacings of substrate and silicon nitride layers, as well as stacking faults in the crystal structure, pin holes or interstitial atoms, tensions in deposited layers can occur. One differentiates between tensile and compressive stress. Additionally, stress caused by temperature changes is possible.

Tension in the nitride layer can be modified by various items:

- ratio of (DCS or) silane and NH3.
- temperature
- plasma parameter

By thermal silicon deposition primarily stoichiometric silicon nitride with low tensile stress is formed. By increasing the gas flow of dichlorosilane silicon-rich silicon nitride is formed. The process can be adjusted so that this nitride is almost stress free. In combination with the excellent properties of thermal silicon nitride it is well suited for micromechanical applications. However many particles are formed during such a process and it requires a lot of experience to keep failure-free operation. With our PECVD Systems we can offer a process for stress free silicon nitride.

Through plasma deposition of silicon nitride, hydrogene is easily integrated and thinner layers which have tensile stress are formed. If silane percentage and ion bombardment are increased, a silicon rich silicon nitride is formed. It is denser and underlies lower stress or even compressive stress. Low deposition temperature stabilizes the nonstoichiometric $Si_{3+x}N_{4-y}$. Chemical composition can be measured by the refraction index of the layer. If plasma is used for deposition of nitride, the feed materials are cracked and reactive radicals are created. Therefore; deposition at lower temperature is possible. Depending on the polarization and excitation frequency of the plasma reactor, molecules or radicals with different velocity and energy strike the surface. This way, layer tension between tensile and compressive stress can be shifted. Additionally, deposition of multilayers which alternately underlie tensile and compressive stress is possible.

For better adjustment of the layer tension, a triode configuration of the plasma reactor, also known as dual-frequency-PECVD, is used. A RF-frequency of 13.56 MH is impressed on the upper electrode, while the sample holder acts upon 400 kHz. The reaction chamber itself is grounded. A high plasma density can be set by the high frequency generator, while through the low frequency generator an acceleration of the ions to the substrate is attained. A Frequency lower than 1 MHz enables ions to follow the polarization change of the plasma - at 13.56 MHZ only electrons can do that.