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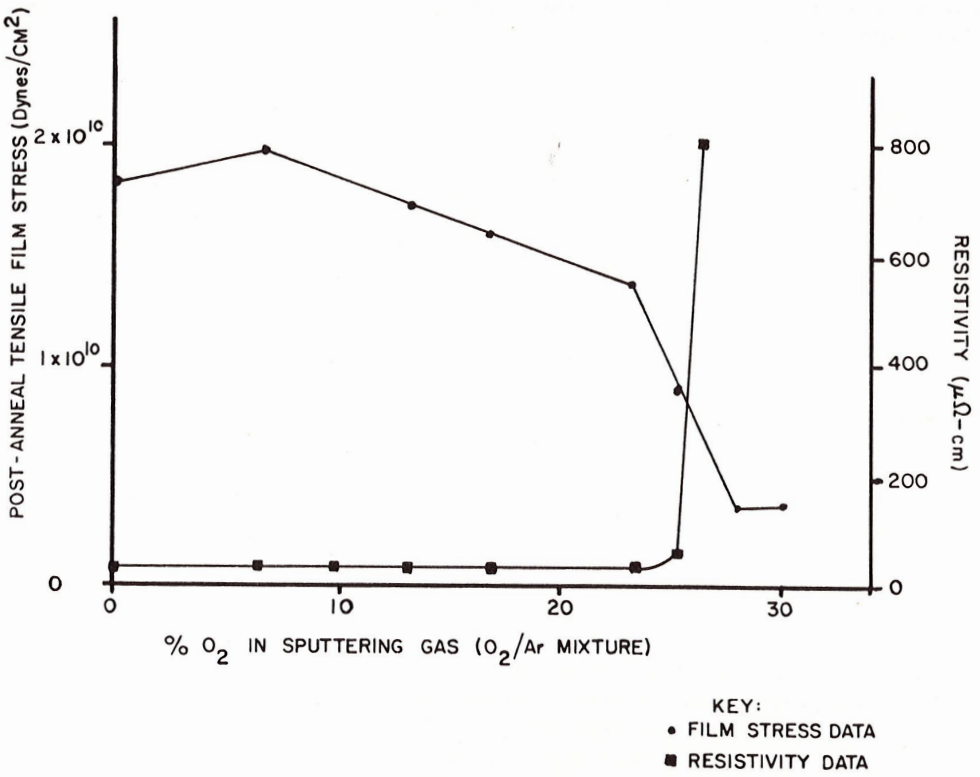
METHOD TO FABRICATE LOW STRESS REFRACTORY METAL SILICIDE FILMS



Polycide and self-aligned silicide technologies have experienced problems such as adhesion loss, silicide "sag", and increased "bird's beak" due to high post-anneal silicide film stress. The high film stress results from the difference between the thermal expansion coefficients of the silicide film and substrate. Limited oxygen incorporation into a silicide film reduces post-anneal film stress while causing only a slight increase in film resistivity. Oxygen is purposely incorporated into the silicide film during deposition. The figure shows post-anneal film stress (1000 degrees C, 30 minutes, N_2) and resistivity as a function of percentage of oxygen in the sputtering gas (oxygen/argon mixture) for titanium silicide ($TiSi_x$) films. For microelectronic applications, the optimum oxygen content for $TiSi_{1.8}$ films is approximately 36 at. % oxygen (as determined by Rutherford backscatter spectrometry). This composition is achieved by depositing

the $TiSi_{1.8}$ film at approximately 20 nm/minute using a sputtering gas pressure of 1 x 10^{-3} torr and a sputtering gas composition of approximately 25% oxygen (O_2) and approximately 75% argon (Ar). At this oxygen level, film stress is lowered significantly, while resistivity is still acceptable.

Low stress silicides may also be useful in applications where low film stress refractory properties are the only material requirements. In these applications, the optimum oxygen content is expected to be greater than 36 at. %.