

## Requirements for Chip Metallization

The metal lines connecting transistors or other components on a **Si** chip must meet many, partially conflicting, requirements. Below is a list, including some materials that do *not* meet the particular requirement very well.

Can you guess the winner?

Advanced

Desired Property	Materials <b>not</b> meeting requirement
Very good conductivity	All but <b>Ag, Cu</b>
High eutectic temperature with <b>Si</b> ( <b>&gt; 800 °C</b> would be good)	<b>Au, Pd, Al, Mg</b>
Low diffusivity in <b>Si</b>	<b>Cu, Ni, Li</b>
Low oxidation rate; stable oxide	Refr. Metals, <b>Mg, Fe, Cu, Ag</b>
High melting point	<b>Al, Mg, Cu</b>
Minimal interaction with <b>Si</b> substrate	<b>Pt, Pd, Rh, V, Ni, Mo, Cr</b> (form silicides easily)
Minimal interaction with poly <b>Si</b>	Same as above
No interaction with <b>SiO<sub>2</sub></b>	<b>Hf, Zr, Ti, Ta, Nb, V, Mg, Al</b>
But must stick well to <b>SiO<sub>2</sub></b>	?
Must also comply with other substrates, e.g. <b>TiN</b>	? ( <a href="#">see example for Al</a> )
Chemical stability, especially in <b>HF</b> environments	<b>Fe, Co, Ni, Cu, Mg, Al</b>
Easy structuring	<b>Pt, Pd, Ni, Co, Au</b>
Electromigration resistant	<b>Al, Cu</b>
.... and many more,...	

The winner is: **Aluminum** (with **<1%** of **Si** and **Cu** added).

**Al**, in fact, is pretty bad - but all others are worse!

Presently (**2001**) a switch to **Cu** takes place (the better conductivity is definitely needed). The industry will pay several **10<sup>9</sup>** Dollars to develop the new material technology and change the production facilities.