

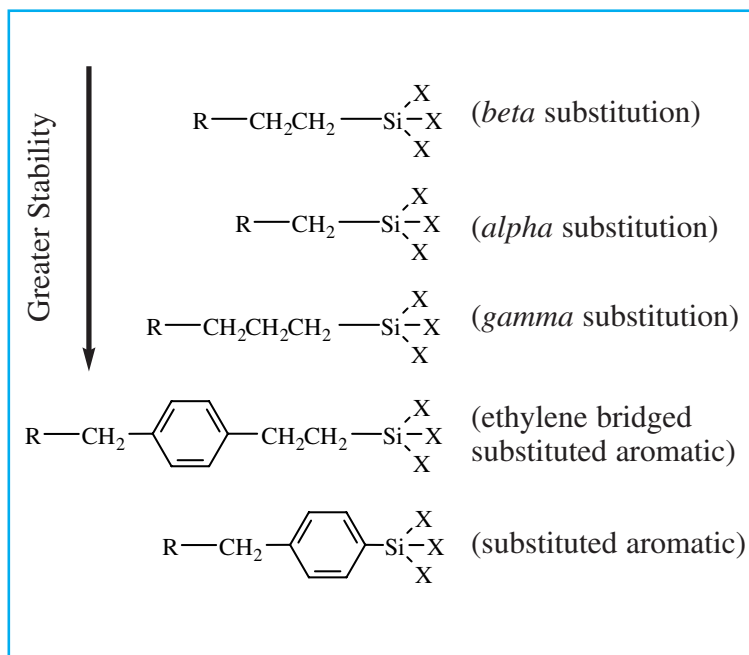
## Thermal Stability of Silane Coupling Agents

The general order of thermal stability for silane coupling agents is depicted. Most commercial silane coupling agents have organic functionality separated from the silicon atom by three carbon atoms and are referred to as gamma-substituted silanes. The gamma-substituted silanes have sufficient thermal stability to withstand short-term process conditions of 350°C and long-term continuous exposure of 160°C. In some applications gamma-substituted silanes have insufficient thermal stability or other system requirements that can eliminate them from consideration. In this context, some comparative guidelines are provided for the thermal stability of silanes. Thermogravimetric Analysis (TGA) data for hydrolysates may be used for benchmarking. The specific substitution also plays a significant role in thermal stability. Electron withdrawing substitution reduces thermal stability, while electropositive groups enhance thermal stability.



Flexible multi-layer circuit boards for cell-phones utilize polyimide films coupled w/chloromethylaromatic silanes.

## Relative Thermal Stability of Silanes



## Thermal Stability of Silanes

SIA0025.0	$\text{CH}_3\text{C}(=\text{O})\text{CH}_2\text{CH}_2\text{Si}(\text{OC}_2\text{H}_5)_3$	220°
SIC2271.0	$\text{ClCH}_2\text{CH}_2\text{CH}_2\text{Si}(\text{OCH}_3)_3$	360°
SIM6487.4	$\text{H}_2\text{C}=\text{C}(\text{CH}_3)\text{C}(=\text{O})\text{CH}_2\text{CH}_2\text{CH}_2\text{Si}(\text{OCH}_3)_3$	395°
SIA0591.0	$\text{H}_2\text{NCH}_2\text{CH}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{Si}(\text{OCH}_3)_3$	390°
SIA0588.0	$\text{H}_2\text{NCH}_2\text{CH}_2\text{NCH}_2-\text{C}_6\text{H}_4-\text{CH}_2\text{CH}_2\text{Si}(\text{OCH}_3)_3$	435°
SIC2295.5	$\text{ClCH}_2-\text{C}_6\text{H}_4-\text{CH}_2\text{CH}_2\text{Si}(\text{OCH}_3)_3$	495°
SIA0599.1	$\text{H}_2\text{N}-\text{C}_6\text{H}_4-\text{Si}(\text{OC}_2\text{H}_5)_3$	485°
SIT8042.0	$\text{CH}_3-\text{C}_6\text{H}_4-\text{Si}(\text{OCH}_3)_3$	530°

25% weight loss of dried hydrolysates as determined by TGA