# Non-Burning Silicone Resin Composite Laminates

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**Research Objective**: To develop non-burning silicone resin composite materials for use in the aircraft cabin interiors.

**Approach**: It is well known that high molecular silicone elastomers and resins have good fire resistance properties. In this study, composites were prepared from both addition (hydrosilylation) and silanol-silanol condensation cured silicone resins. Composites made from the addition cured resins had peak heat release rates around 100 kW/m$^2$ under an incident heat flux of 50 kW/m$^2$. The heat release rate, CO and smoke yield increased as the carbon content in the resin increased. Even though these results were encouraging, non-burning properties were not observed. To minimize the carbon content in the resin, silanol-silanol condensation cured resins were studied. Laminates were prepared by vacuum bagging techniques from phenyl and methyl silicone resins and either Nicalon® or E-glass fabrics. Their thermal stability and fire performance were studied by thermal gravimetric analyses (TGA) and cone calorimetry, respectively.

**Accomplishment Description:** Condensation cured silicone resins or silsesquioxanes can be represented by the general formula $(RSiO_{1.5})_n$, where R = Me or Ph. As shown in Figures 1 and 2, the methyl resin had a higher thermal stability and a lower heat release rate than the phenyl resin. Laminates fabricated from the methyl silicone resin and either Nicalon® fabric (42 v%) or E-glass fabric (55 v%) had peak heat release rates below 10 kW/m$^2$ under an incident heat flux of 50 kW/m$^2$. Even with continuous sparking, neither of the composites ignited during the course of the test (20 minutes). The composites retained their shape and up to 78 % of their tensile strength after the test. Little to no delamination was seen. The heat release rate, CO and smoke yields were very low compared to laminates made with organic resins. This difference is shown in Figures 3 and 4 for a methyl silicone resin composite made with E-glass fabric (55 v%) and a CytecFiberite composite laminate (MXB 6070/7781 prepreg was used).

**Significance:** The heat release rate, CO and smoke yield of a silicone resin is a function of the carbon content in the cured resin. By using silanol-silanol condensation cured methyl resins, non-burning composites with lower CO and smoke yields can be fabricated. Even in the absence of halogenated or other fire retardants, the fire performance is already superior to the phenolic resins currently used in aircraft interiors.

**Expected Results:** While the addition cure silicone resin composite laminates have low flammability, the condensation cure methyl resin composite laminates are essentially non-burning. These fire resistant silicone resin composite laminates are possible candidates for next generation aviation applications.

**References:**

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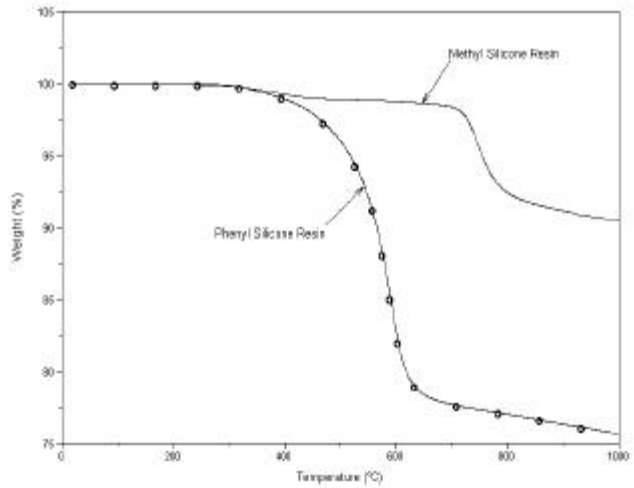


**Figure 1**. TGA (Helium atmosphere) of phenyl and methyl silicone resins cured at 200 °C for 18 hours.

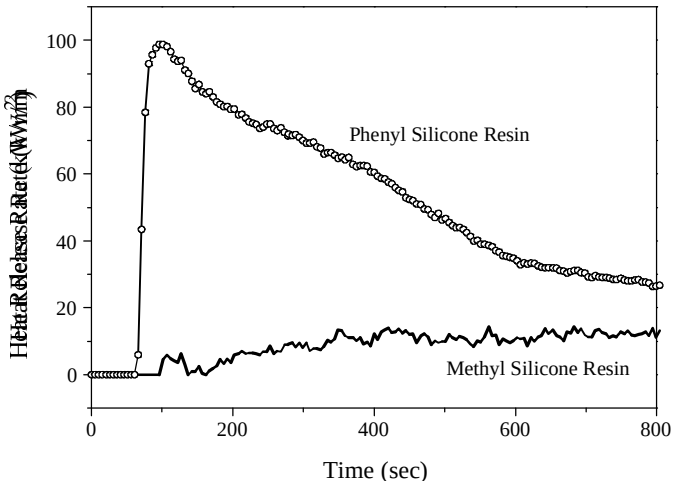


**Figure 2**. Plot of heat release rates of phenyl and methyl silicone resins cured at 200 °C for 18 hours.

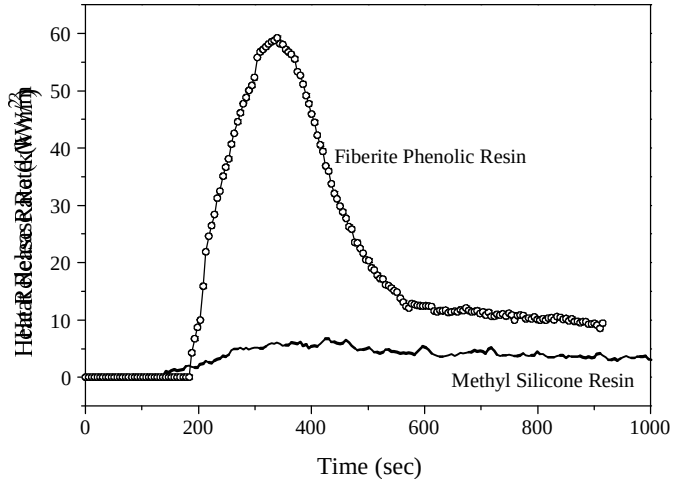


**Figure 3**. Plot of heat release rates of methyl silicone resin and Fiberite phenolic resin composite laminates.

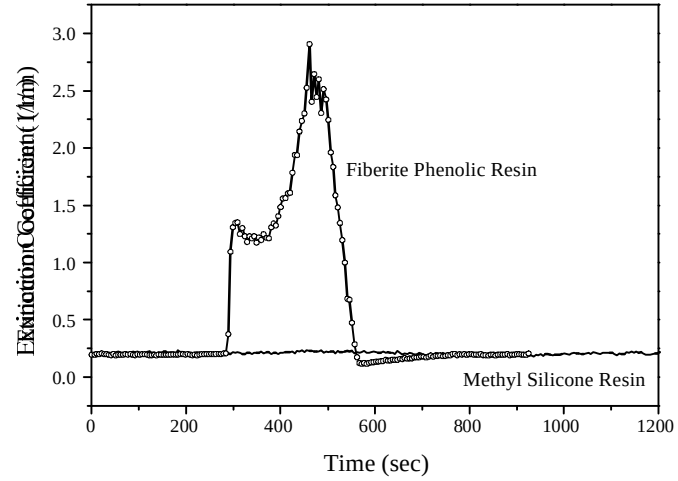


**Figure 4**. Plot of extinction coefficient of methyl silicone resin and Fiberite phenolic resin composite laminates.