**Feature Project**

# Tackification of Textile Fiber Preforms in RTM and High Temperature SCRIMP

By Chih-Hsin Shih (Lee)

One of the major steps in resin transfer molding (RTM) is preform fabrication. A net-shape-preform is often made by bonding the fiber layers together using tackifiers. The ideal tackifier should be able to eliminate any springback of the fiber layers after preforming in order to achieve good preform dimension control. The tackifier also needs to provide enough adhesion between the fiber layers so that the preform can maintain its integrity. The presence of the tackifier, however, may affect the permeability and fiber wetting of the preform in the mold filling process, as well as mechanical properties of molded composite parts. To optimize the preforming process, we investigated fabric formability, preform dimension control, preform permeability, fiber wetting, and tackifier compatibility with the matrix resin based on a commercial tackifier (PT 500 from 3M).

The tackifier location and distribution depend strongly on tackifier powder size, tackifier concentration, application methods and preforming conditions. Smaller powder size and higher tackifier concentration tend to produce better coverage on the fabric surface. The tackifier location may change during preforming depending on temperature. The SEM pictures in Figure 1 show that if the tackifier is uncured (or partially cured) and initially located on the fabric surface, it will remain outside the fiber tows when the preforming temperature is low (e.g. 80°C). However, when the preforming temperature is high (e.g. 160°C) the tackifier will be pulled into the fiber tows by the capillary force.

(a) 160 °C (b) 80°C

Figure 1. Photomicrographs of PT500 tackified fiber mats (70X)

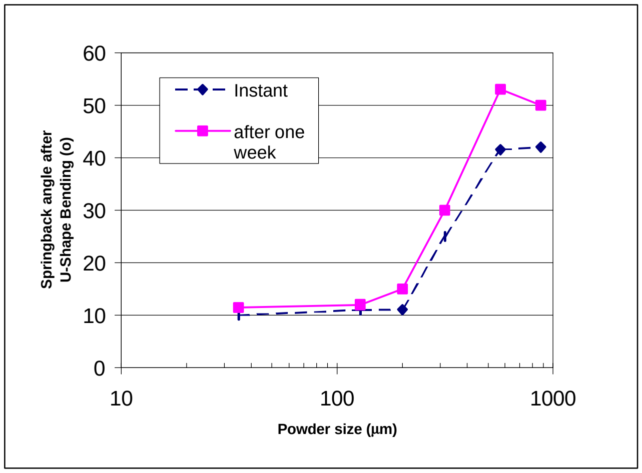


Figure 2. Effect of PT500 tackifier powder size on preform springback control after U-shape bending (original PT500 powder size is 95% less than 40 µm).

The effect of tackifier particle size on the springback control of IM7 fiber preform under U-shape bending is shown in Figure 2. The results indicated that the majority of the springback occurred immediately after preforming and smaller particle size resulted in better springback control.

Figure 3 shows the effect of tackifier concentration and preforming conditions on the preform permeability. The normalized permeability is defined as the ratio of the permeability between the tackified preform and the fabric layers without adding any tackifier (8.27 Darcy at 58% fiber volume fraction). For preforming at 80°C for 1 hour, the preform permeability decreased as the tackifier concentration increased. For preforming at 160°C for 20 minutes, the preform permeability increased as the tackifier concentration increased. A maximum value was attained at 17% tackifier concentration (permeability is 4.5 times that of the untackified fiber preform), and decreased afterwards. This can be explained by the tackifier location from the SEM pictures shown in Fig. 1. The tackifier inside the fiber tows (160°C) shrunk the fiber tows and increased the space outside the tows. This, in turn, increased the permeability of the fiber preform.Adding too much tackifier (>17%) forced some tackifier to stay outside fiber tows and, consequently, the permeability of the fiber preform started to decrease. On the other hand, if the tackifier remained on the surface (80°C) of the fiber mat, it would block the resin flow and, consequently, reduce the permeability.

The effect of tackifier on fiber wetting was studied by flow visualization. More micro-voids appeared in the tackified fabric than in the one without tackifier. The flexural strength of the composite showed that as long as the composites have the same void content, there is no significant difference between tackified (<5%) and non-tackified composites. More details about the tackification are given in a recent CAPCE report (T-99-01).

Our current work focuses on applying tackification technology to high temperature SCRIMP for aerospace applications. In SCRIMP, atmospheric pressure is the only force that would compress the preform to the desired fiber volume fraction (i.e. >60%) and vacuum is the only driving force for mold filling. Tackifier-assisted fiber consolidation and permeability control is very crucial in this process.