Thermax® N990 in TPU Composites

Supported by the National Research Council of Canada (NRC), Cancarb performed testing of Thermax® N990 in thermoplastic polyurethane (TPU) composites. Thermax® thermal carbon black was compounded in TPU at loadings ranging from 0 to 20 percent by weight. The grade of TPU used in the study has applications in cable sheathing, hoses, damping elements, profiles, and railway pads. It offers outstanding hydrolysis resistance, low temperature flexibility, and resistance to micro-organisms along with good abrasion resistance, tensile strength, and damping behavior.

Advantages of adding Thermax® N990 to TPUs:

- Reduction in viscosity when N990 is loaded up to 10% by weight
- Increase in Shore D hardness
- Increase in tensile modulus
- Slight increase in tensile strength
- Up to 35% higher elongation at break than pristine polymer
- Minimal reduction in abrasion resistance
- Significant improvement in UL-94 horizontal burn rate for unfoamed samples
- Dark grey color with blue undertone (CIELAB: L*≈19, a*≈0, b*≈-1)
- Excellent dispersion
- High electrical resistivity (non-conductive compounds)

The test formulations can be found in Table 1. Three loading levels of N990 were compared to one loading level of N762 and a combination of N990 and glass bubbles from 3M. Each formulation was foamed using two weight percent Safoam® FPE-50. Viscosity, Shore D hardness, tensile, abrasion resistance, UL-94 HB, and color data were collected for each composite, both unfoamed and foamed.

Table 1. Test formulations, weight percent

Elastollan® 1170[1]	Thermax® N990	N762	3M™ iM30K[2]
95	5	-	-
90	10	-	-
80	20	-	-
80	-	20	-
80	10	-	10

[1] Produced by BASF
[2] Produced by 3M

The effect of N990 loading on TPU composites can be seen in the following figures.

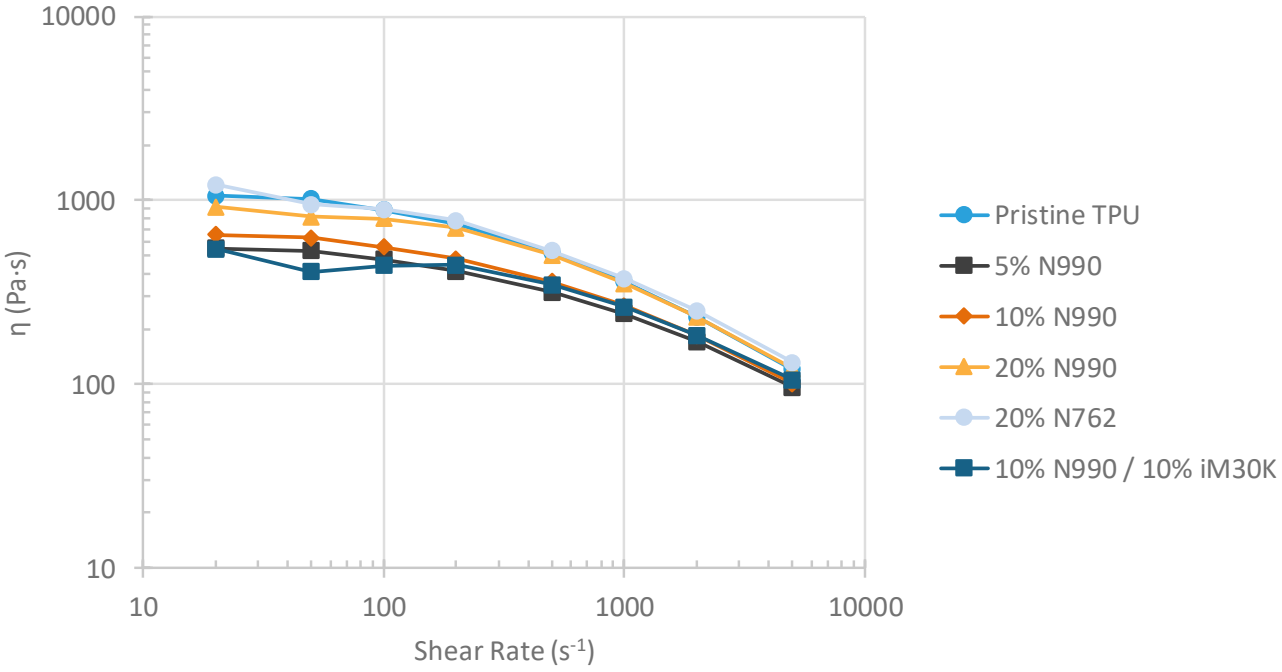

Figure 1. Viscosity versus shear rate measured on a capillary rheometer at 190°C. Viscosity was lower for composites with 5% and 10% N990 by weight. This translates to increased throughput and reduced power consumption during processing.

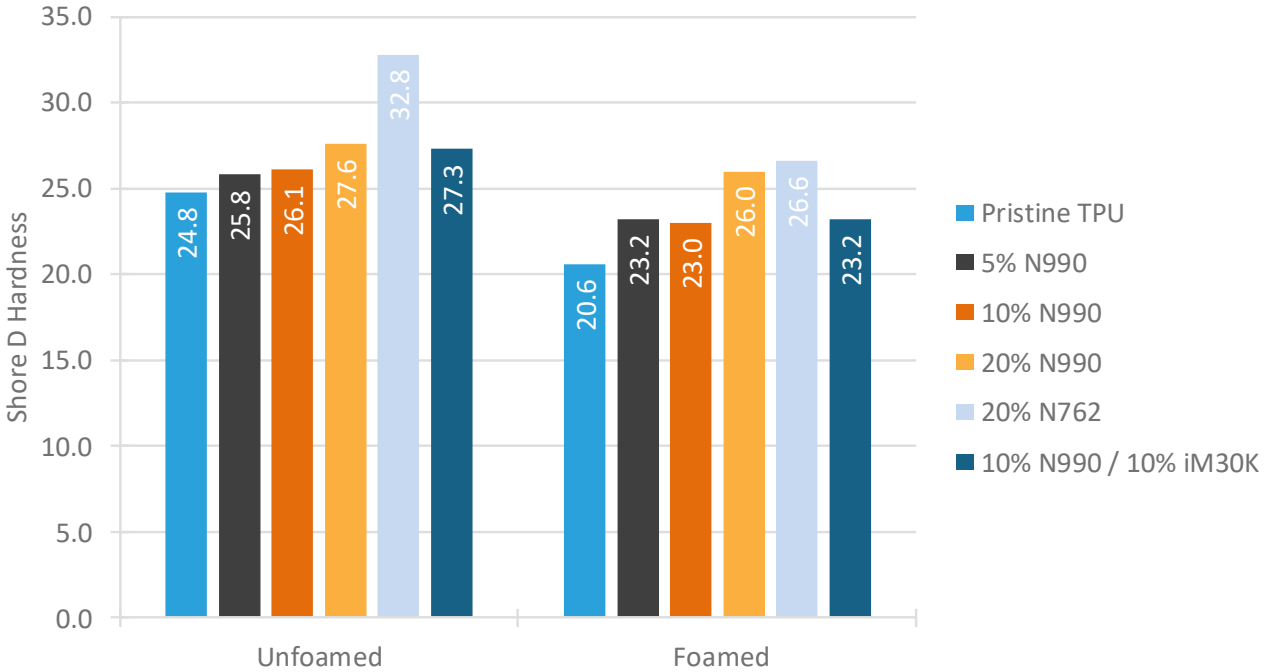

Figure 2. Shore D hardness for composites. Hardness increased with increasing filler content. Reduction of hardness was observed for foamed composites.

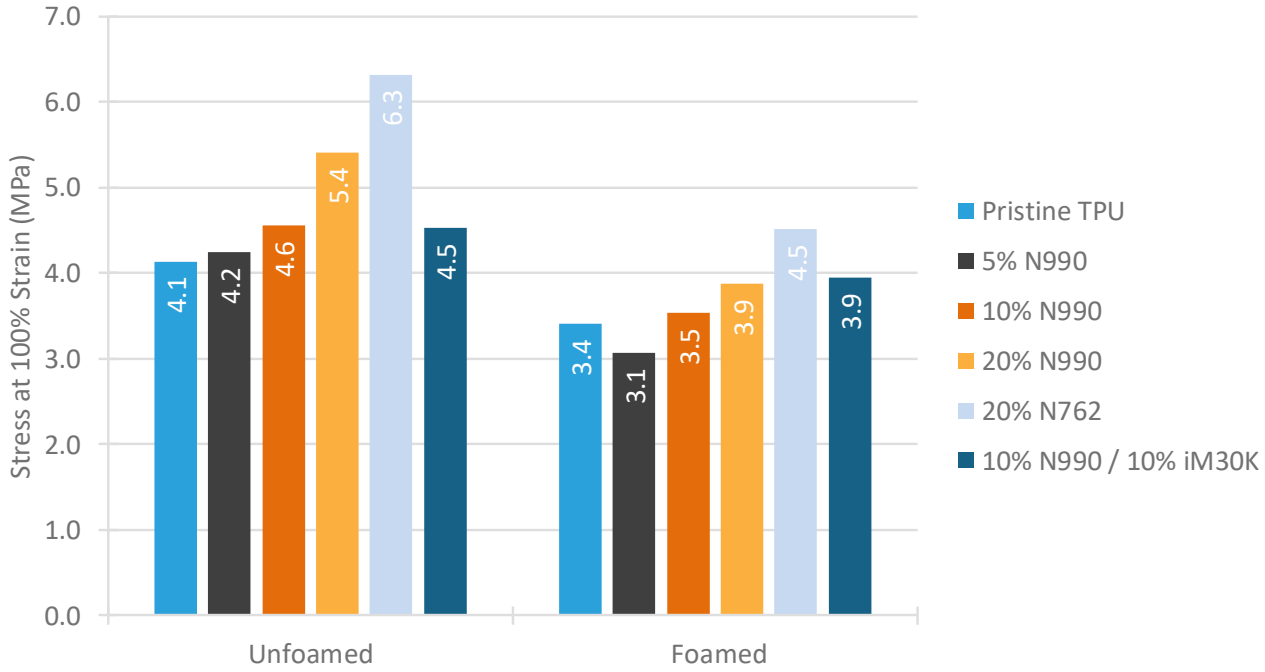

Figure 3. Stress at 100% strain for the composites. Values generally increased with increasing filler content. Stress was lower for foamed composites as compared to their unfoamed counterparts.

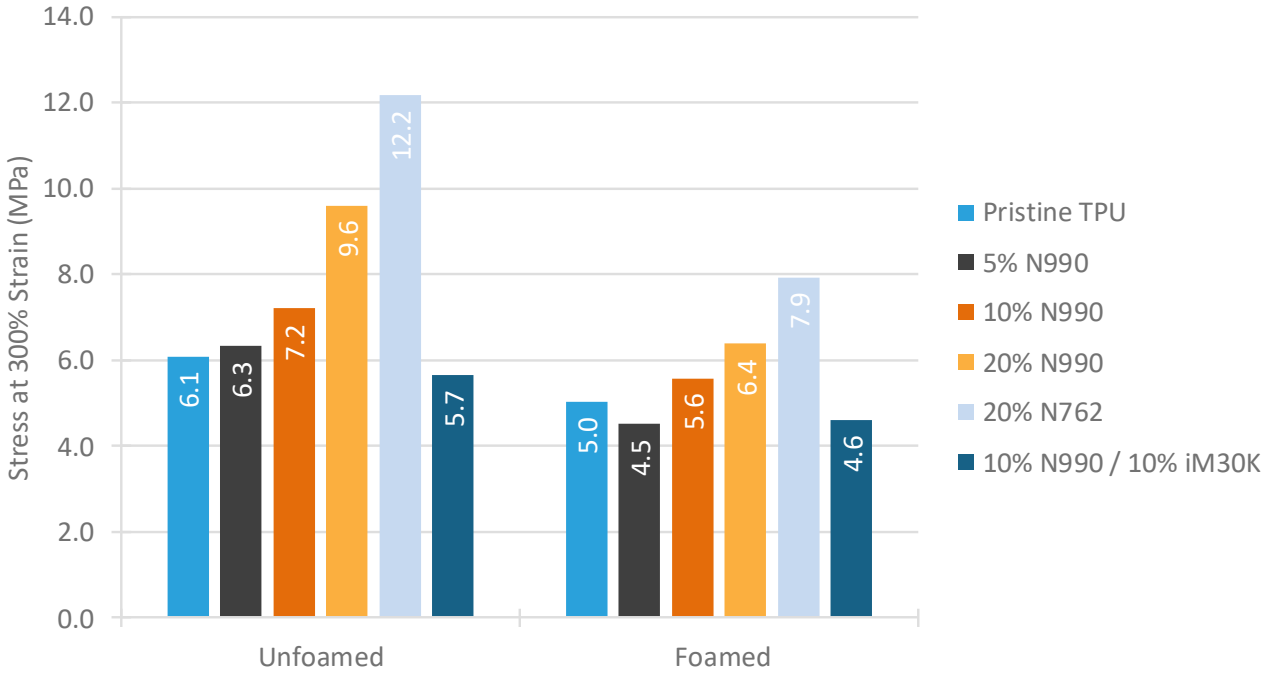

Figure 4. Stress at 300% strain for the composites. Values increased greatly with increasing carbon black content. Values decreased slightly with the addition of glass beads.

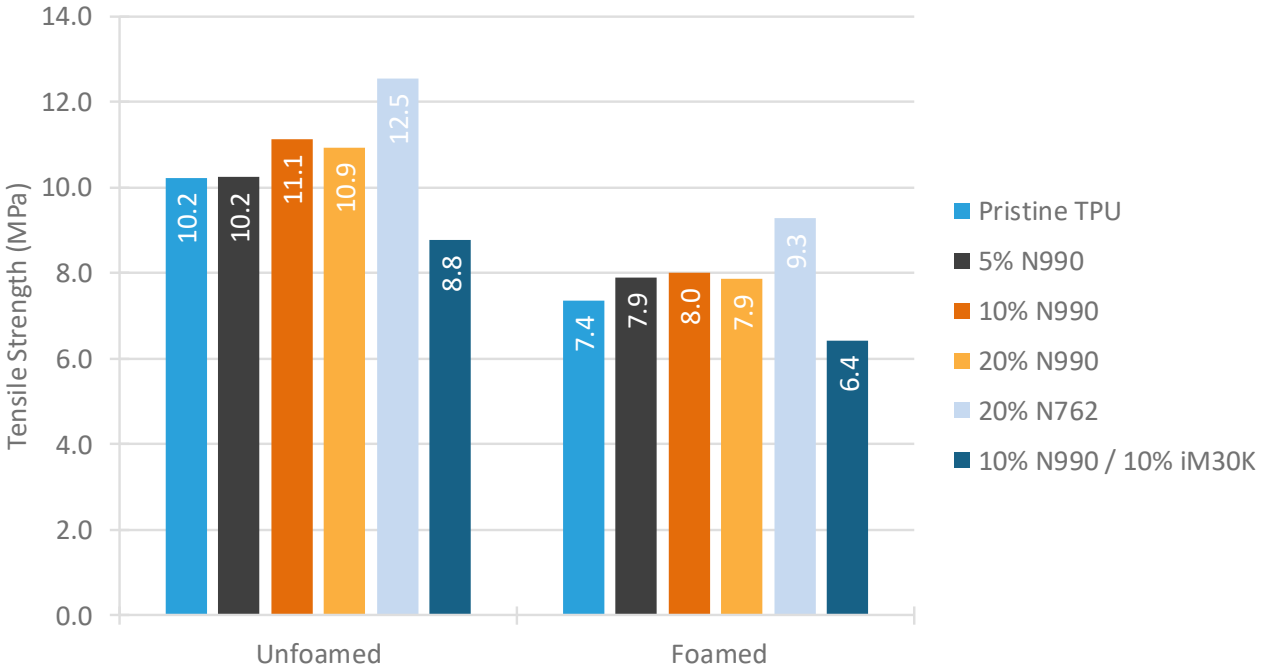

Figure 5. Tensile strength of the composites measured at a crosshead speed of 20 in/min. Tensile strength increased with the addition of carbon black, particularly N762. Tensile strength was lower with the addition of glass beads and after foaming.

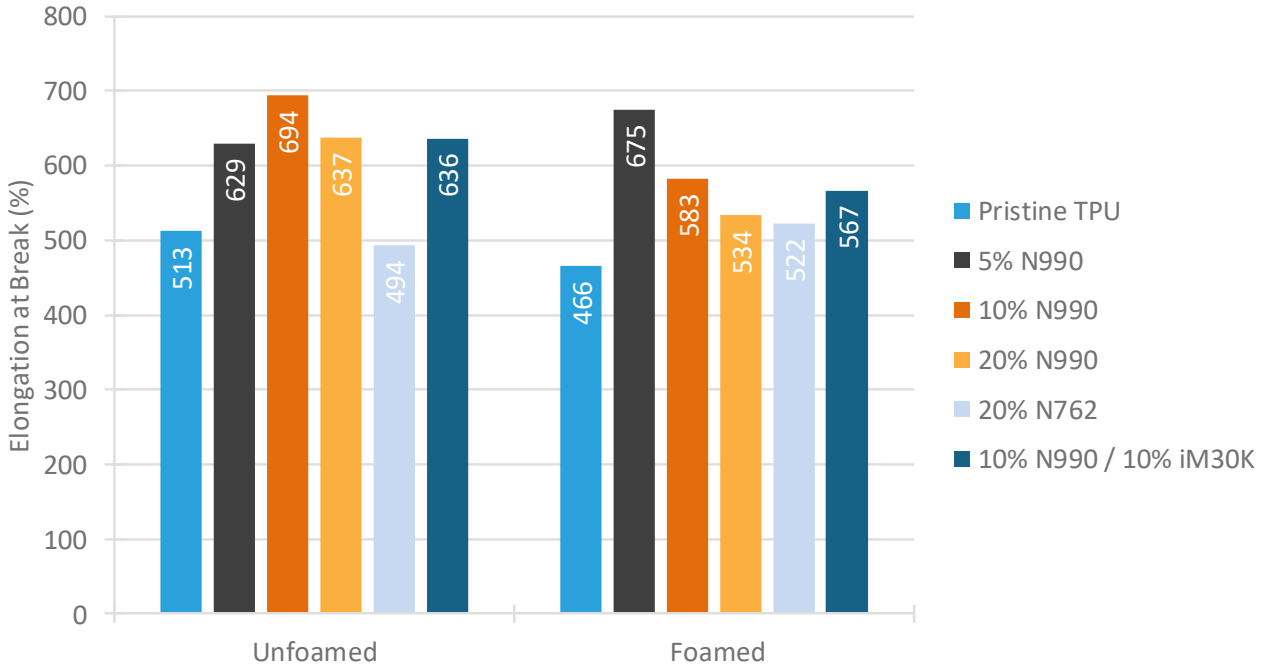

Figure 6. Elongation at break of the composites. Elongation was significantly higher for the unfoamed and foamed samples containing N990.

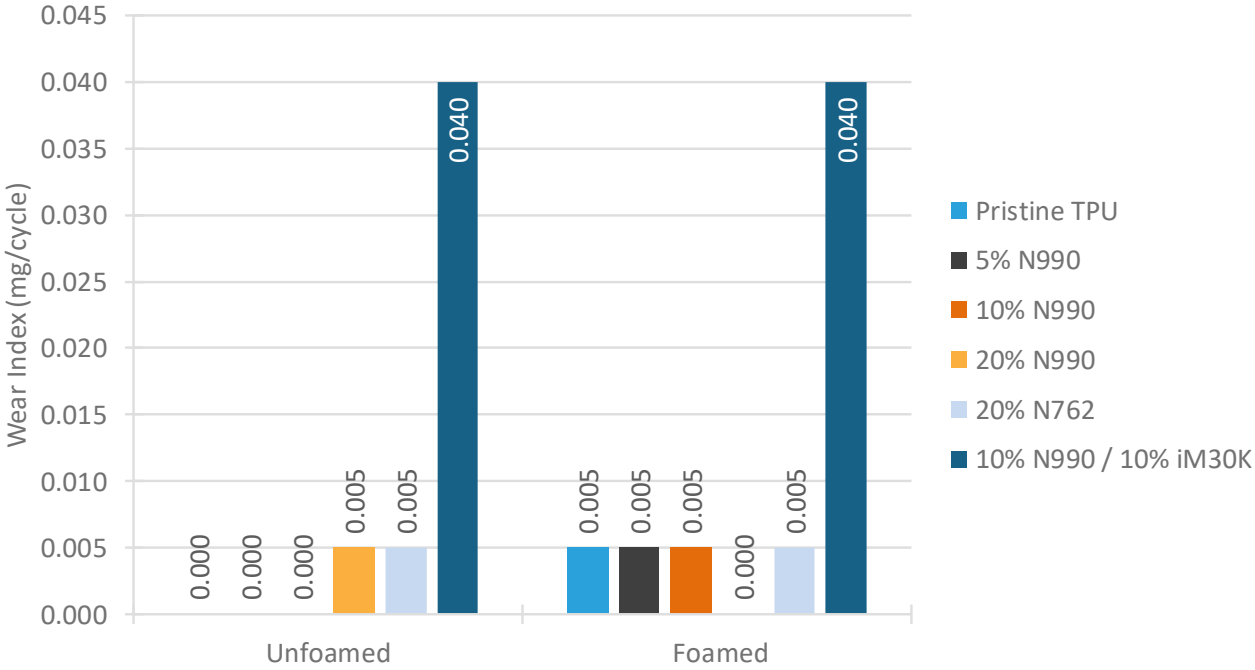

Figure 7. Abrasion resistance of the composites as measured by ASTM D5963. Wear increases slightly at higher carbon black loadings. Wear increases significantly with the addition of glass beads.

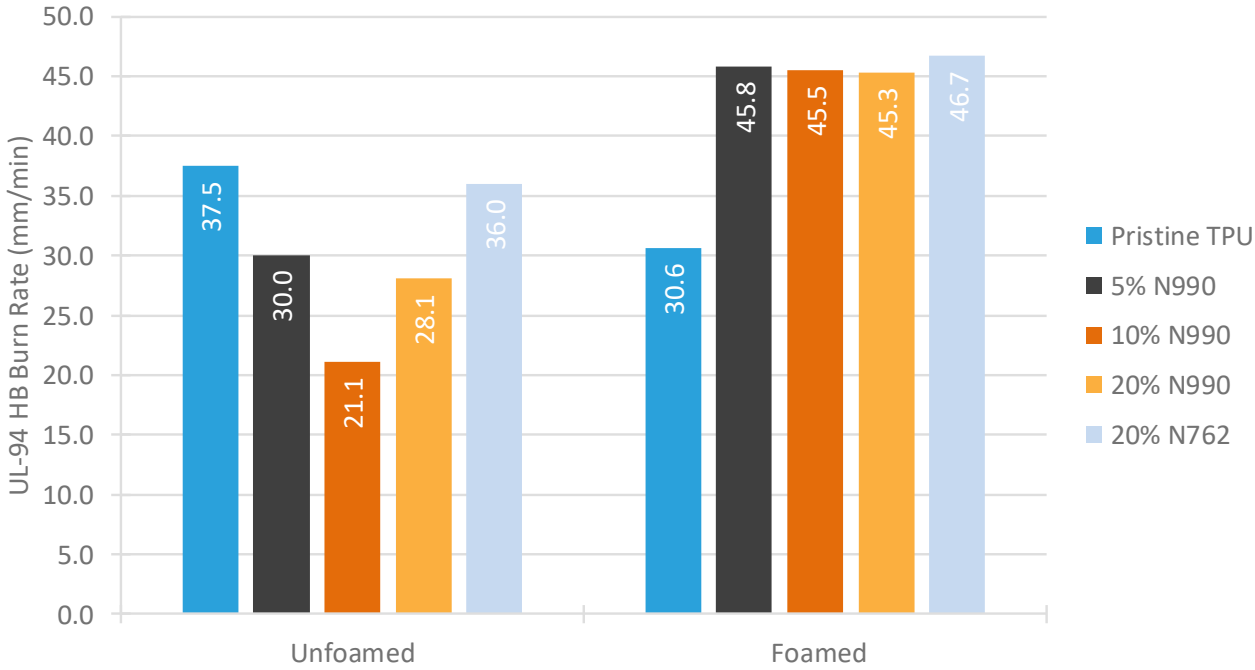

Figure 8. UL-94 horizontal burn rate for the composites. The addition of N990 decreased the burn rate in the unfoamed samples. In foamed samples, the addition of carbon black increased the burn rate.

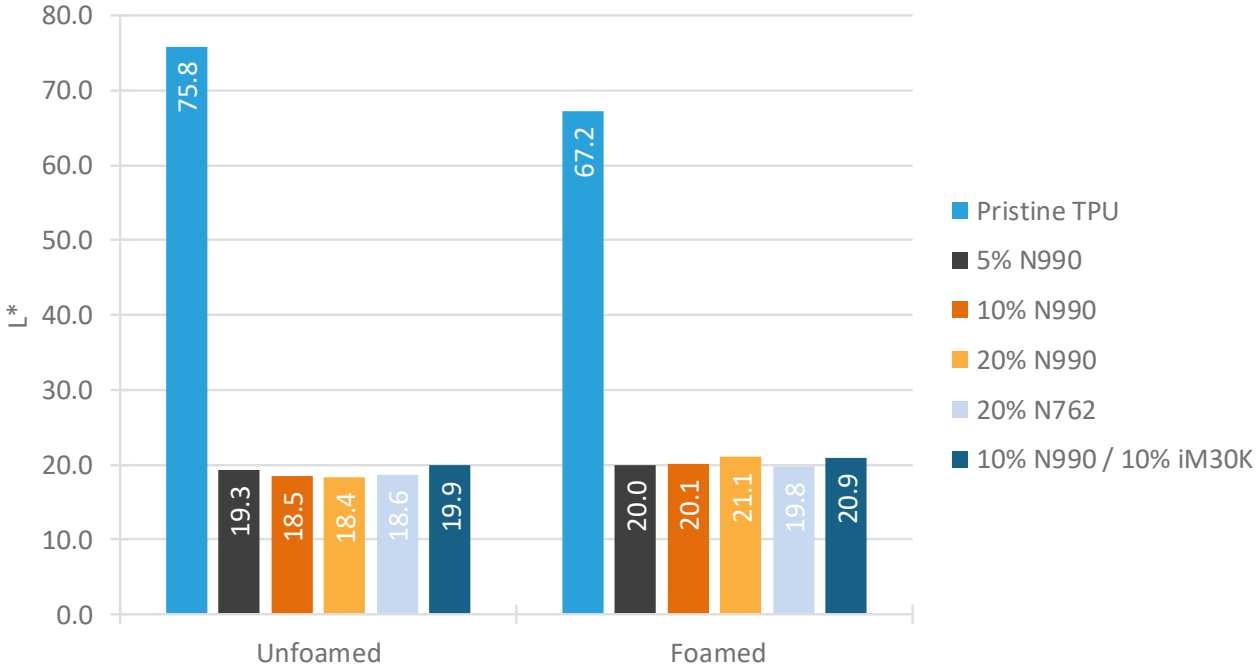

Figure 9. The L* value for the composites. The addition of carbon black lowered the L* to ~19 for unfoamed and ~20 for foamed samples.

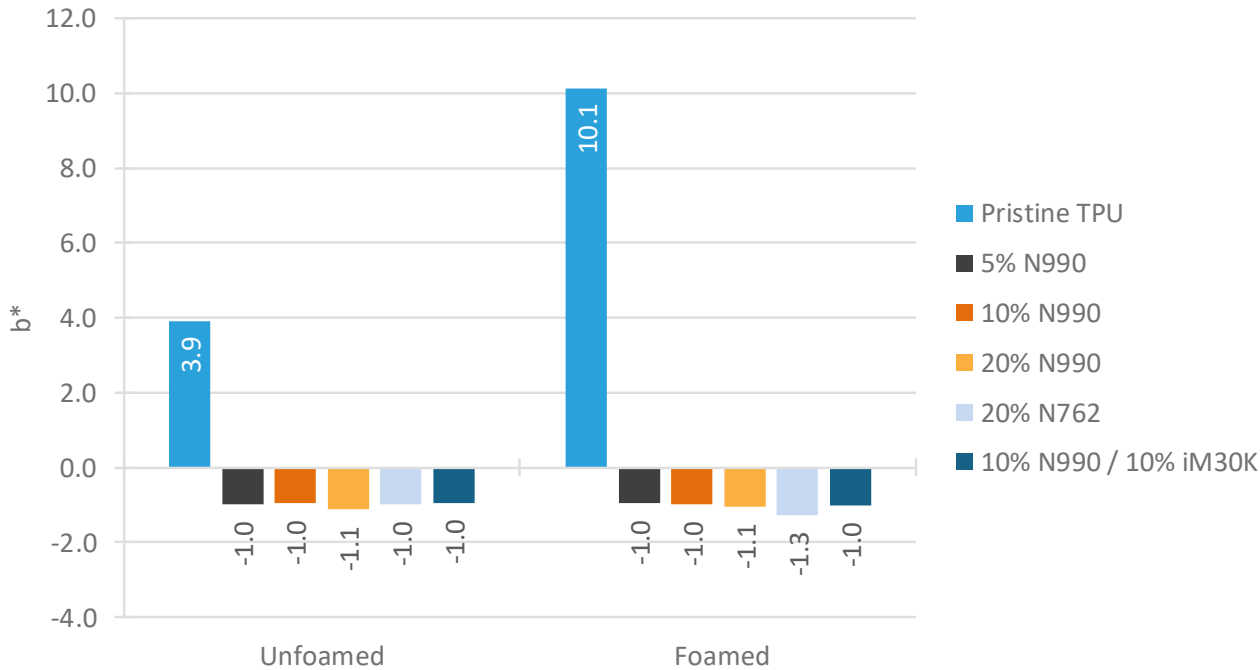

Figure 10. The b* value for the composites. The addition of carbon black provided a slightly blue undertone, with b* values around -1.