Thermax® N990 in Polypropylene Composites

With the help of the National Research Council of Canada (NRC), Cancarb performed testing of Thermax® N990 in thermoplastic composites. Thermax® thermal carbon black was compounded in polypropylene (PP) at loadings ranging from 0 to 40 percent by weight. Thermoplastics are commonly compounded with mineral fillers to reduce cost and improve on properties such as tensile strength and heat deflection temperature. Testing results confirm that thermal carbon black can be used to replace the mineral fillers to reduce weight and cost among other advantages listed below.

Advantages of adding Thermax® N990 to thermoplastics:

- Lower density when replacing mineral fillers – **large potential weight savings** (up to 10% at high loadings)
- Less abrasive than mineral fillers
- Excellent dispersion
- Increase in tensile modulus of up to 140% (elasticity)
- High electrical resistivity (non-conductive compounds)
- Increase in heat deflection temperature (HDT)
- Excellent black coloring at 1% loading
- Class A surface finish capable

Table 1. Polymer grades

Polymer Type	Grade	Manufacturer
Polypropylene (PP)	Pro-fax® PD702	LyondellBasell
Polypropylene (PP)	Accutech® HP0334T40L	A. Schulman
*No coupling agents were used		

Table 2. Test formulations

Thermoplastic Matrix	Thermax® N990 Thermal Black						N762 Furnace Black	Talc
PP	1 wt.%	3 wt.%	5 wt.%	10 wt.%	20 wt.%	40 wt.%	5 wt.%	40 wt.%

The effect of N990 loading on polypropylene composites can be seen in the following figures and tables. The data for the formulation with 40% talc was based on previously published data for A. Schulman Accutech® HP0334T40L.

In Figure 1, the complex viscosity showed only modest increases up to 20 wt.% of N990. At 40 wt.%, significant increases in viscosity and changes in rheological behavior were observed.

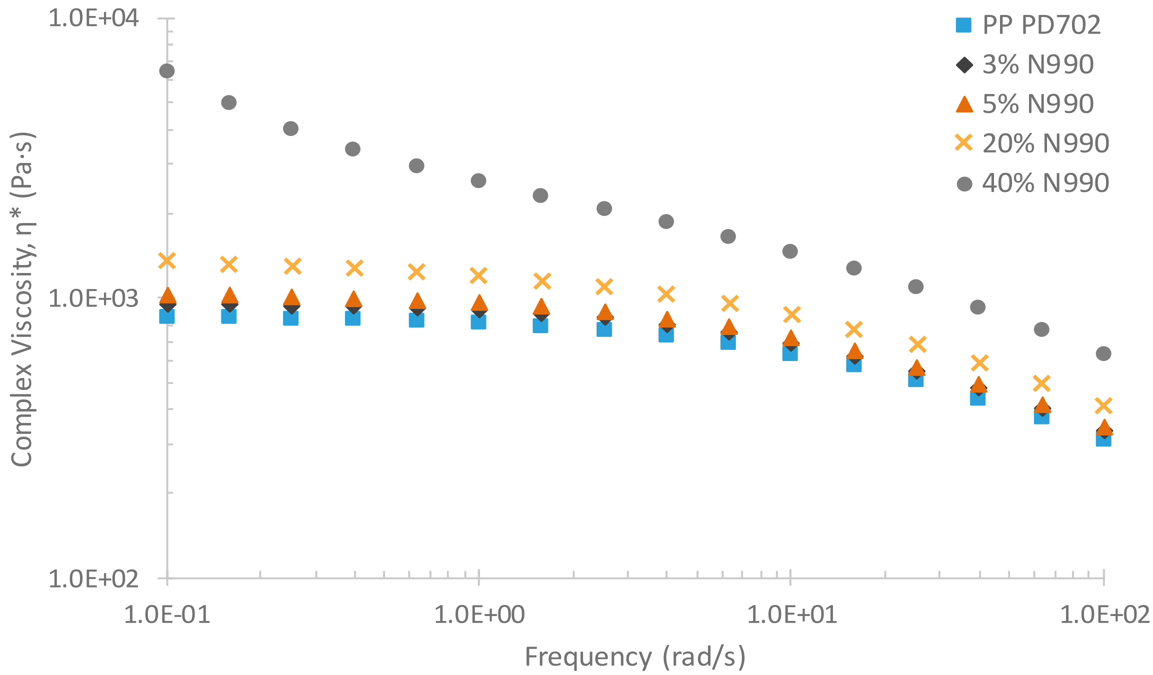

Figure 1. Complex viscosity curves at 200°C and varying frequency. As N990 loading increased, viscosity also increased. There was no significant viscosity change up to 5 wt.% N990 loading.

The tensile modulus values of the polypropylene composites are shown in Figure 2. A clear trend of increasing modulus with increasing filler loading was noted.

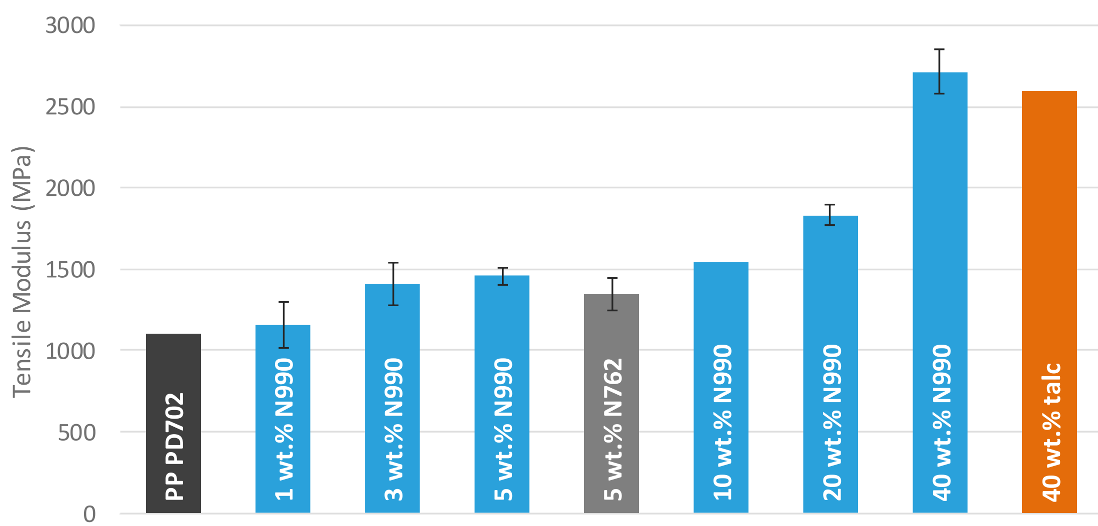

Figure 2. Tensile modulus of polypropylene composites. Tensile modulus increased gradually with filler loading.

Figure 3 contains the ultimate tensile strength data which was maintained above 25 MPa for all samples.

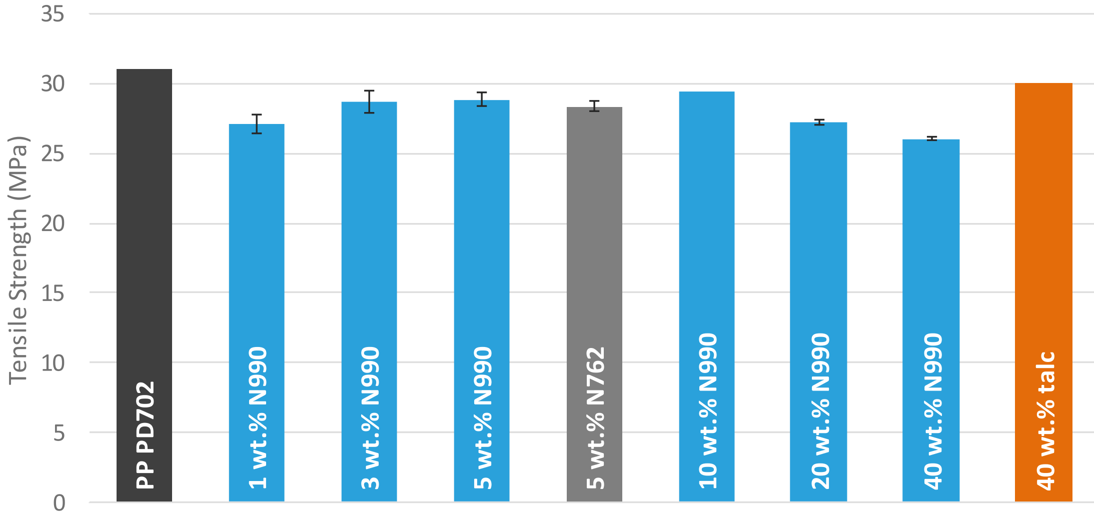

Figure 3. Ultimate tensile strength for polypropylene composites. Tensile strength was maintained above 25 MPa for all materials.

Figure 4 shows the elongation at break of the materials. Elongation was maintained up to 5 wt.% loading and then declined sharply with increasing loading.

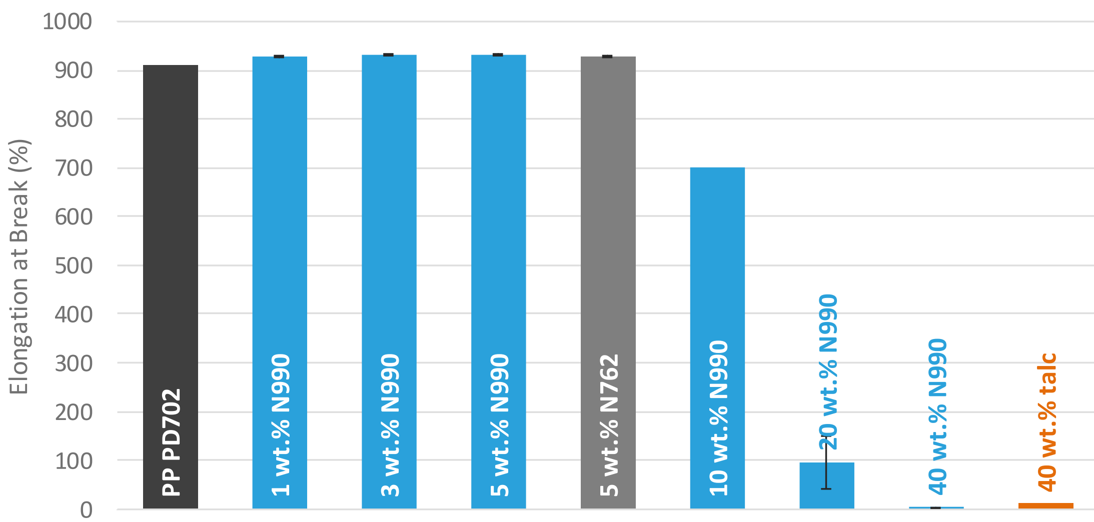

Figure 4. Elongation at break of polypropylene composites. Elongation was maintained up to 5 wt.% N990 loading but decreased drastically at higher loadings for both carbon black and mineral filler.

The impact strengths of the materials, shown in Figure 5, tended to decrease at higher N990 loadings, but were maintained at levels similar to the pristine polymer at N990 loadings up to 5 wt.%.

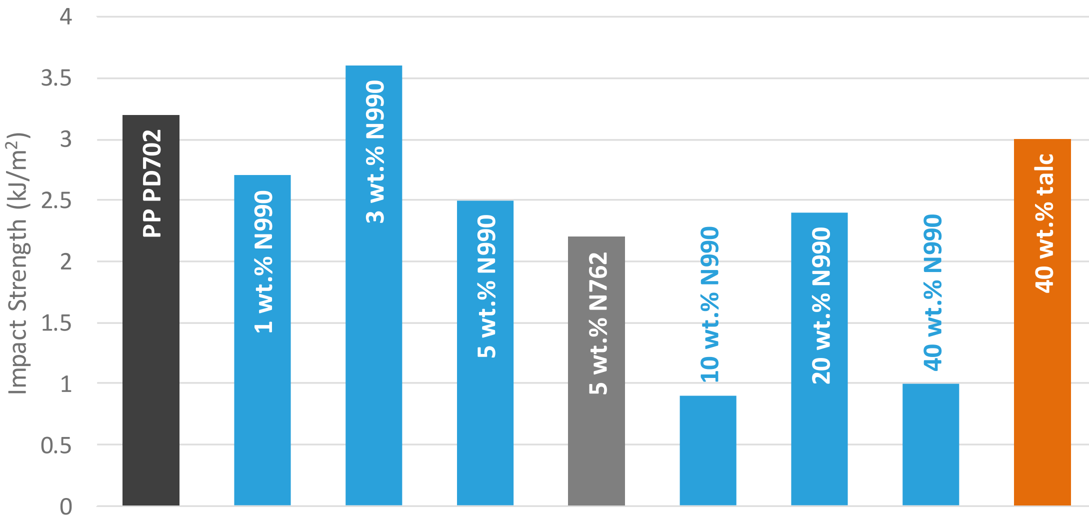

Figure 5. Izod impact strength of polypropylene composites. Impact strength was maintained up to 5 wt.% N990 loading but decreased significantly at higher loadings.

Figure 6 shows the heat deflection temperatures for the composites which tended to increase as N990 loading increased. However, the heat deflection temperature of polypropylene loaded with 40 wt.% N990 was about 20°C lower than the reported value for polypropylene filled with 40 wt.% talc.

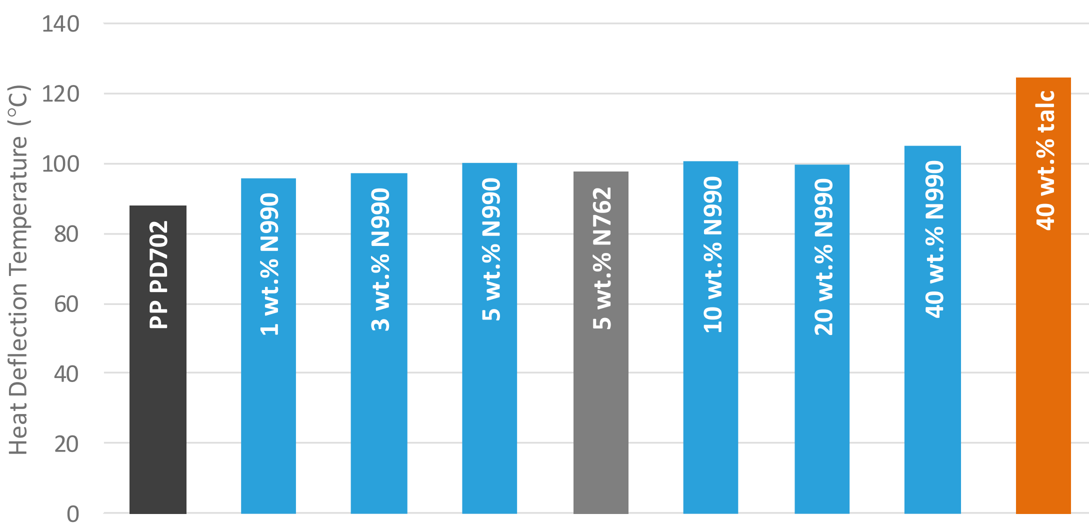

Figure 6. Heat deflection temperature of polypropylene composites. As filler loading increased, so did the heat deflection temperature. There was a 20°C discrepancy between the composite using Thermax® N990 carbon black and that using talc mineral filler at 40 wt.% loading.

Color data for the composites is contained in Table 3. The **CIELAB color space** was used which represents color as three values: *L** for the lightness from black (0) to white (100), *a** from green (−) to red (+), and *b** from blue (−) to yellow (+). At 1 wt.% N990, the material was a very dark gray with a slight blue undertone. With increasing loading, the color tended to lighten up a bit, possibly due to poorer dispersion of the carbon black. The undertone remained consistent as loading increased.

Table 3. L*a*b* color data for polypropylene composites

Filler Loading	L*	a*	b*
1 wt.% N990	19.0	-0.2	-1.4
3 wt.% N990	19.7	-0.2	-1.3
5 wt.% N990	22.1	-0.2	-1.0
5 wt.% N762	19.2	-0.2	-1.3
20 wt.% N990	21.2	-0.3	-1.6
40 wt.% N990	23.6	-0.4	-1.8

Figure 7 shows the potential weight savings from using N990, with a specific gravity of 1.8 g/cm^3, instead of talc, with a specific gravity of 2.8 g/cm^3. At 40 wt.% loading, the density of the composite loaded with N990 was about 10% less than the one loaded with talc.

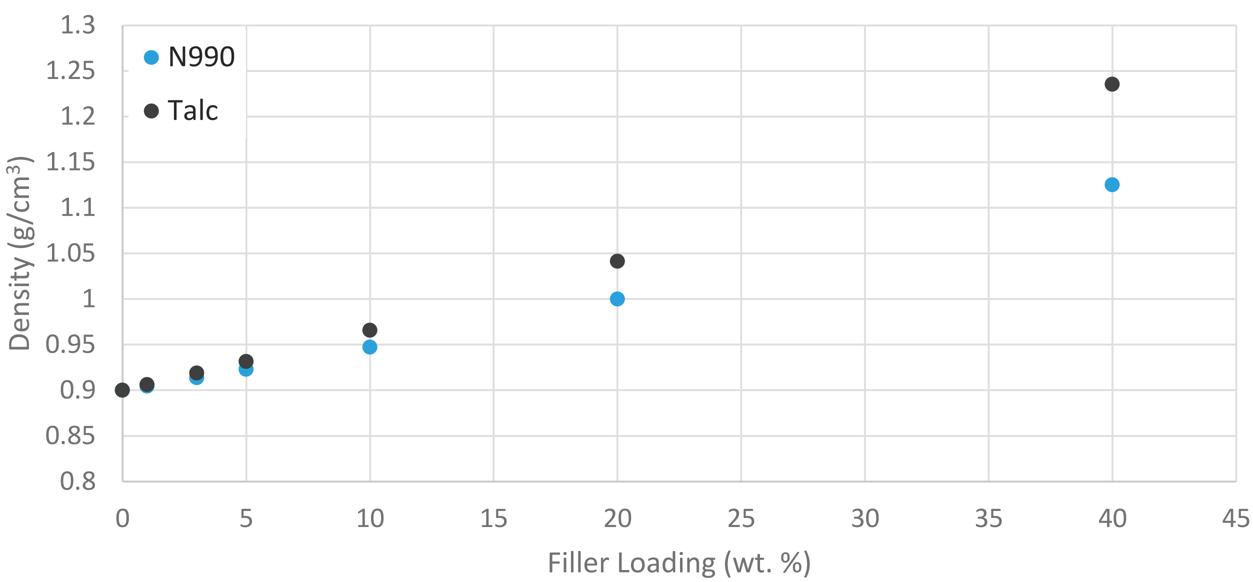

Figure 7. Density of polypropylene composites as a function of filler loading. At 40 wt.% loading, there was a 10% weight savings when using N990 over talc.

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