Thermax® N990 in HDPE Films

With the help of the National Research Council of Canada (NRC), Cancarb performed testing of Thermax® N990 in high density polyethylene (HDPE) films. HDPE has a service temperature range from -40°C to 80°C, high crystallinity, high tensile strength, excellent impact strength, and good corrosion resistance. It has good vapor but poor gas barrier properties. HDPE films can be used in many applications such as bags, liners, and packaging.

The benefits of Thermax® N990 include:

- Increased tensile modulus
- Excellent dispersion in the polymer matrix
- Tensile strength and elongation are maintained at 3 wt.% loading
- Impact resistance properties are maintained up to 10 wt.% loading
- Black color with blue undertone

In the study, N990 was added at different loadings to the HDPE matrix in an extruder. The compound formulations can be found in Table 1. The compounds were then extruded into cast films. Tensile, impact resistance, DSC, CIELAB, and SEM testing were then completed on the films. All films displayed good dispersion of the N990 particles. Melting temperatures, crystallization temperatures, and degrees of crystallization were similar between the compounds. Further test results can be seen in the Figures and Tables on the following pages.

Table 1. HDPE formulations

Matrix	HDPE 8800S			
N990 content (wt.%)	0.0	3.0	10.0	20.0
Film thickness (µm)	112	112	112	122

Table 2. CIELAB color data for the cast films containing N990. Full color is reached below 3 wt.% loading. Color is black with slight blue undertone. Films are completely opaque at these loadings.

Thermal Black Content (wt.%)	**L***	**a***	**b***
3	25.2	0.0	-0.7
10	25.4	0.0	-0.6
20	25.7	0.1	-0.5

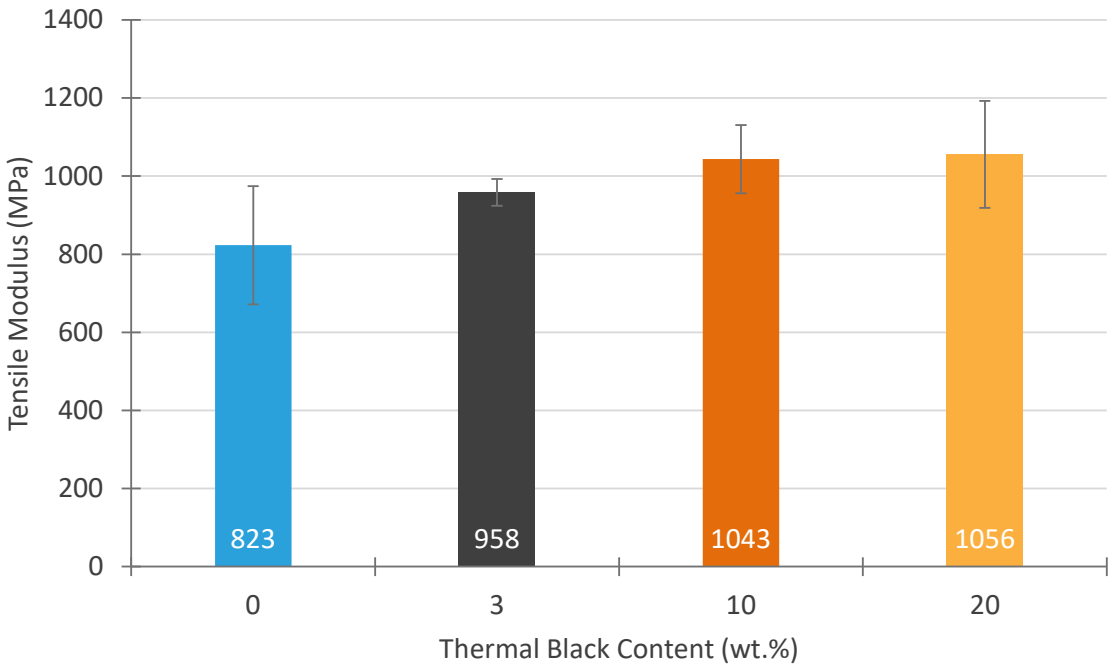

Figure 1. Tensile modulus of the cast films. Modulus tended to increase as N990 content increased.

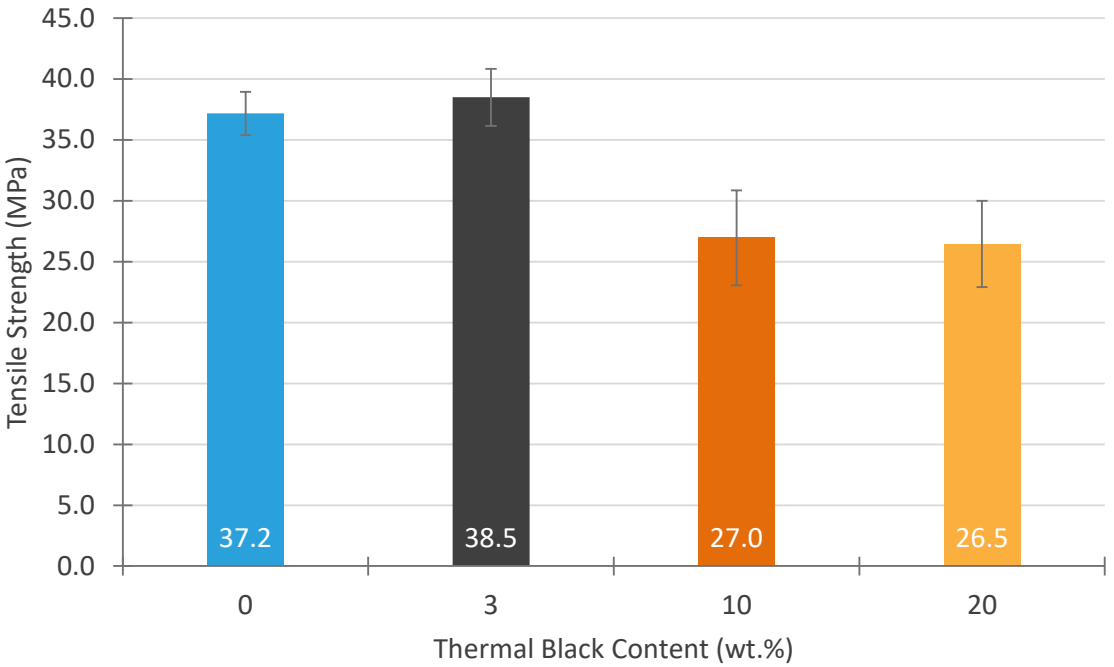

Figure 2. Tensile strength of the cast films. Tensile strength was maintained at 3 wt.% N990. At higher N990 loadings, there was a decrease in tensile strength.

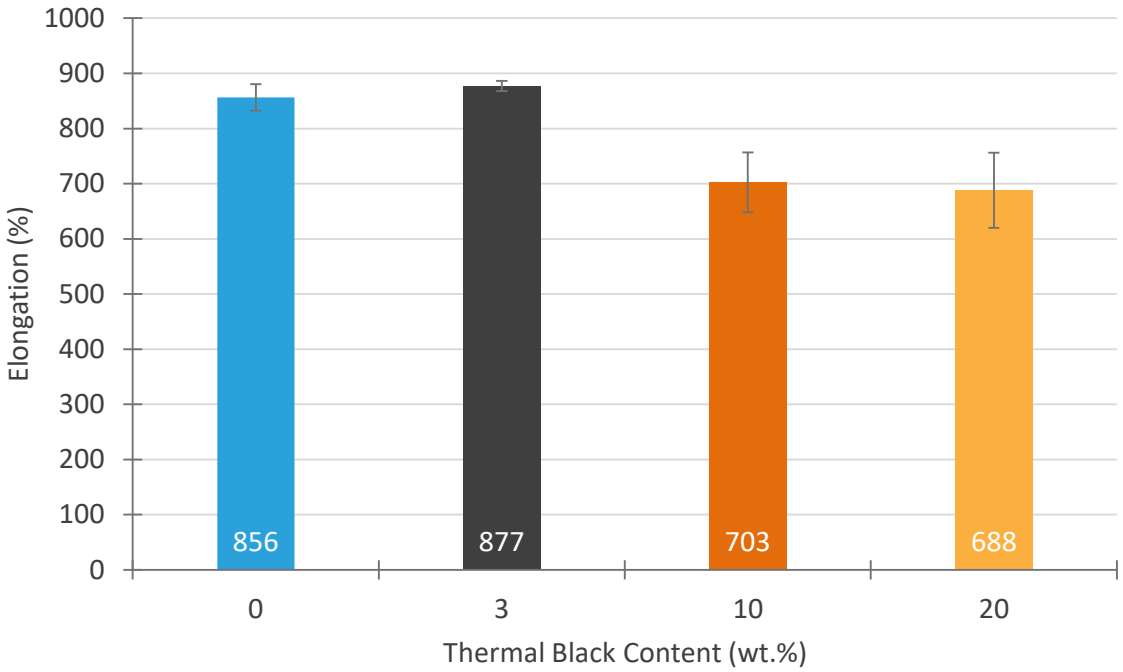

Figure 3. Elongation of the cast films. Elongation was maintained at 3 wt.% N990. At higher N990 loadings, there was a decline in elongation

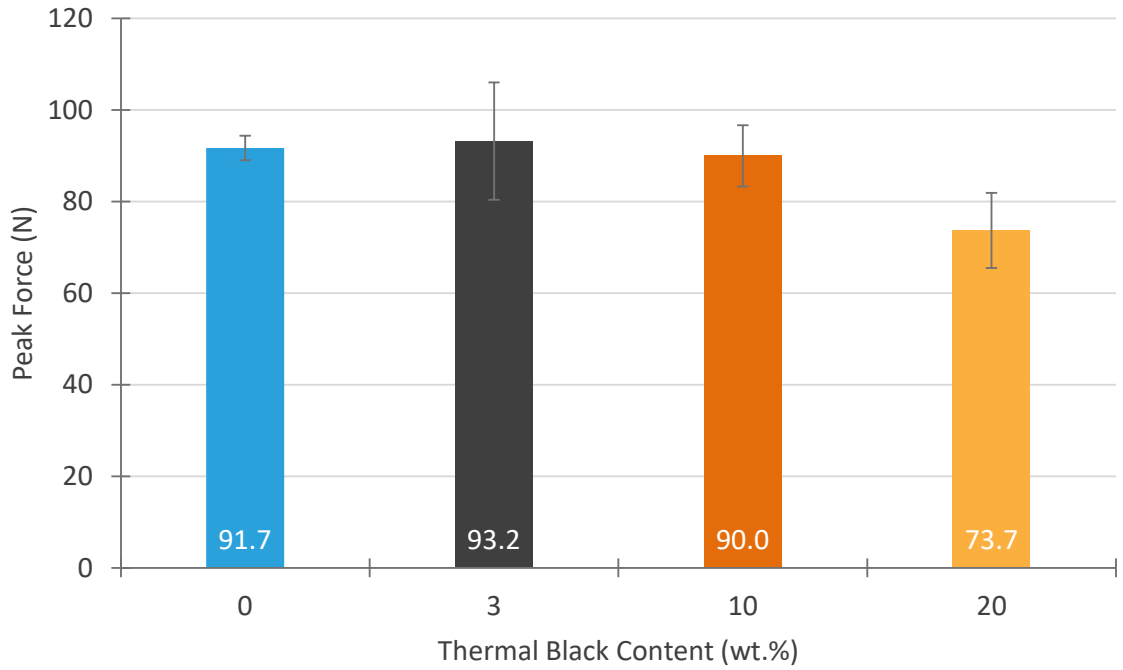

Figure 4. Peak force of the cast films measured during impact resistance testing according to ASTM D3763. Peak force was maintained up to 10 wt.% N990. At a loading of 20 wt.% N990, a reduction in peak force was observed.

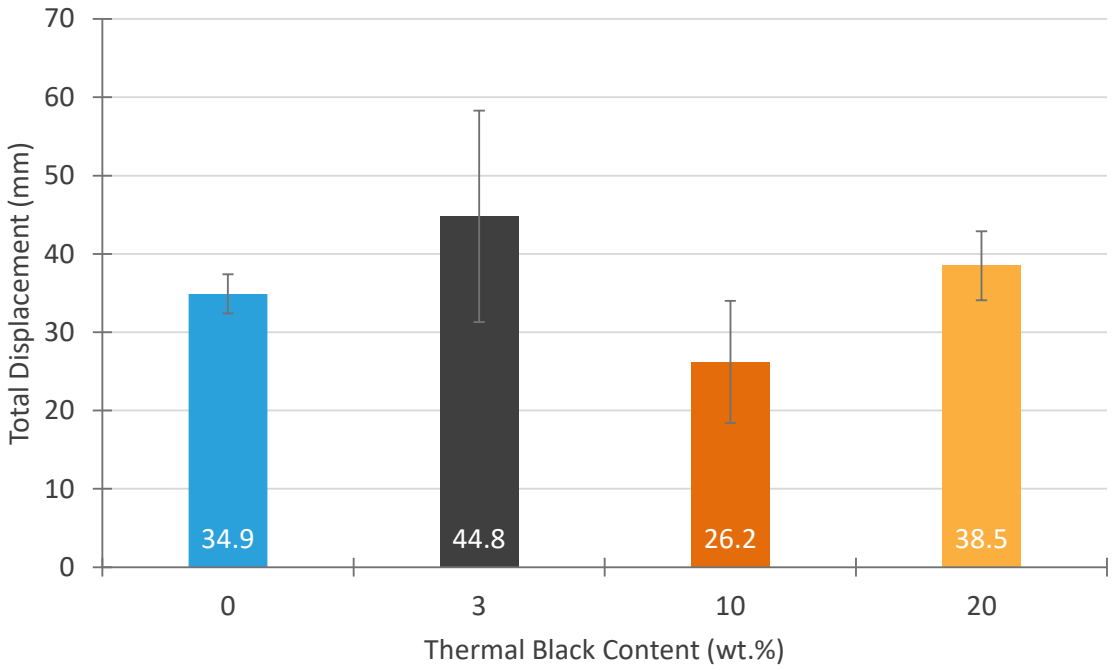

Figure 5. Total displacement of the cast films measured during impact resistance testing according to ASTM D3763. There were no significant differences in total displacement.

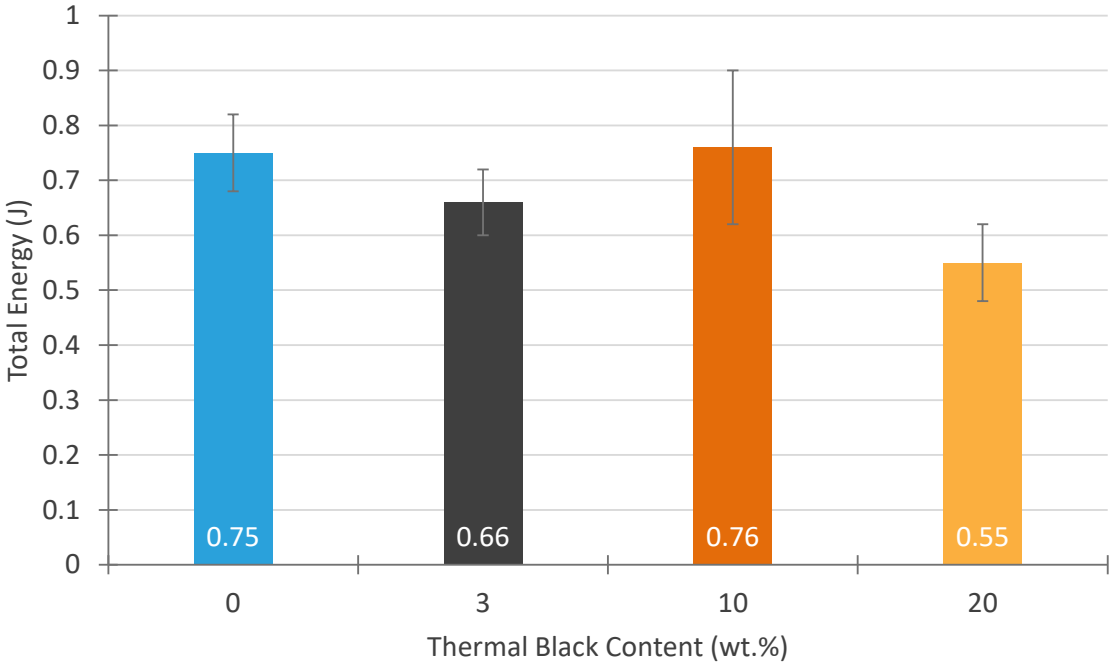

Figure 6. Total energy to puncture the cast films measured during impact resistance testing according to ASTM D3763. Total energy was maintained up to 10 wt.% N990. At a loading of 20 wt.% N990, there was a decrease in total energy.

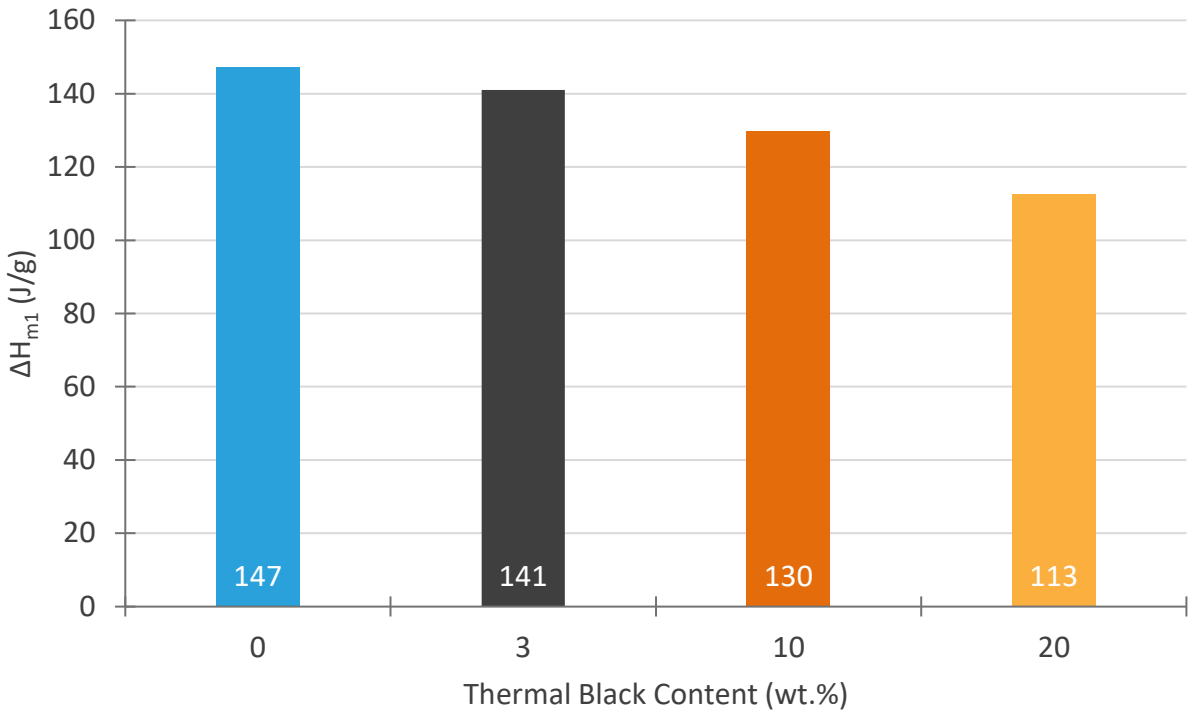

Figure 7. Enthalpy of melting of the cast films measured by DSC. Enthalpy decreased proportionally with decreasing HDPE content.