Thermax® as a Pigment in Silicone

In this study, Thermax® medium thermal carbon black was compared to other black pigments in a silicone rubber compound. Pigments are typically added at relatively low loadings. In many cases, several different pigments will be added to achieve a particular color.

The benefits of Thermax® found in the study were:

- Large particle size provides a low tinting strength which allows for more forgiveness when targeting a specific shade
- Large particle size also generates a strong blue undertone, particularly when added with titanium dioxide to produce greys

The silicone compound test formulations are provided in Table 1. Two grades of Thermax® were compared to a low color furnace black and black iron oxide. The nitrogen surface area (NSA) and oil absorption number (OAN), measures of particle size and structure respectively, of the carbon black grades are provided in Table 2. The color in masstone and tint were measured using the CIELAB color space. In this space, color is represented using three values: L* for lightness from black (0) to white (100), a* from green (-) to red (+), and b* from blue (-) to yellow (+). For tint measurements, a tinting ratio of 10:1 titanium dioxide to black pigment was utilized. Additionally, samples were made with additional Thermax® to match the darkness of the furnace black sample.

Table 1. Test Formulations

	Masstone				Tint					
Ingredient (phr)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
65 duro Dow compound	100	100	100	100	100	100	100	100	100	100
Thermax® N991UP	**0.5**	**-**	**-**	**-**	**0.5**	**-**	**-**	**-**	**1.15**	**-**
Thermax® N990UP	**-**	**0.5**	**-**	**-**	**-**	**0.5**	**-**	**-**	**-**	**1.33**
Low color furnace black	-	-	0.5	-	-	-	0.5	-	-	-
Black iron oxide	-	-	-	0.5	-	-	-	0.5	-	-
Titanium dioxide	-	-	-	-	5	5	5	5	5	5

Table 2. Size and structure properties of carbon blacks

Property	Thermax® N991UP	Thermax® N990UP	Low Color Furnace Black (Typical)
Nitrogen surface area (m^2/g)	10.5	9.3	30
Oil absorption number (mL/100g)	35.9	41.8	70

In Table 3, the masstone color is presented. The colors of all samples were close. The difference in color (ΔE*) between the Thermax® and furnace black samples was 1.3. The ΔE* between the Thermax® and iron oxide samples was 1.0.

In Table 4, the tint color is presented. Differences in darkness were much more notable than for the masstone samples. At 0.5 phr Thermax®, L* values were around 60 compared to 50 for the furnace black and 70 for the iron oxide. The Thermax samples had greener and bluer undertones as represented by the more negative a* and b* values. In order to match the darkness of the furnace black, additional samples were created using more Thermax®. When formulated to match darkness, the Thermax® samples had significantly greater blue undertone as indicated by the b* values. The difference was greater than 1 and thus quite noticeable to the human eye. This finding suggests that Thermax® may be a superior option for producing cool grey products.

Table 3. Masstone color of silicone with 0.5 phr black pigment

Pigment	L*	a*	b*
N991UP	**24.2**	**0.2**	**-0.2**
N990UP	**24.3**	**0.2**	**-0.3**
Low color furnace black	23.0	0.2	0.0
Black iron oxide	23.6	0.6	0.3

Table 4. Tint color of silicone with black pigment and 5 phr titanium dioxide

Pigment	L*	a*	b*
0.5 phr N991UP	**59.4**	**-1.9**	**-6.0**
1.15 phr N991UP	**48.8**	**-1.6**	**-6.5**
0.5 phr N990UP	**61.6**	**-1.9**	**-5.9**
1.33 phr N990UP	**48.9**	**-1.7**	**-6.7**
0.5 phr low color furnace black	49.1	-1.4	-5.3
0.5 phr black iron oxide	70.2	-0.9	-3.1

Figure 1. Picture of masstone color of silicone with 0.5 phr N991UP

Figure 2. Picture of tint color of silicone with 0.5 phr low color furnace black (left), 0.5 phr N991UP (middle), and 0.5 phr black iron oxide (right). All samples contained 5 phr TiO_2 as white pigment.

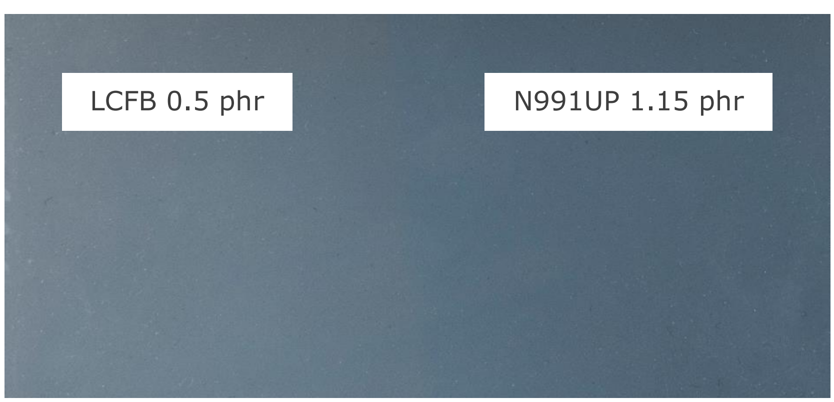

Figure 3. Picture of tint color of silicone, formulated to achieve same L* color, with 0.5 phr low color furnace black (left) and 1.15 phr N991UP (right). Both samples contained 5 phr TiO_2.