

**Pigments with high scattering power S in the 700-1200 portion of the NIR spectrum.**

These pigments can be considered alone, or as undercoats. Low absorption K is also required. Typical coating thickness is 20 micrometers (0.8 mil). February, 2003.

Pigment	Scattering coefficient S in 700-1200 nm range ( $\text{mm}^{-1}$ )	Absorption coefficient K in 700-1200 nm range ( $\text{mm}^{-1}$ )	Overall NIR reflectance over white (700-2500 nm range)	Overall NIR reflectance over black (700-2500 nm range)
TiO <sub>2</sub> white	~250	<1	0.88	0.64
Nickel titanate yellow	~250	~2	0.78	0.64
Chrome titanate yellow	~250	~~2	0.80	0.61
Iron oxide red (Fe <sub>2</sub> O <sub>3</sub> )	~200	~~10	0.54	0.38
Cadmium orange	200	<1	0.87	0.47
Cadmium yellow	200	<1	0.83	0.34
IR black 797	200	~30	0.46	0.35
IR black 411	150	~30	0.43	0.33
Chromium oxide green (Cr <sub>2</sub> O <sub>3</sub> )	120	~12	0.51	0.39
Cobalt titanate teal (Co <sub>2</sub> TiO <sub>4</sub> )	120	~3	0.67	0.47
Interference orange (TiO <sub>2</sub> on mica)	120	<1	0.89	0.50
Interference red (TiO <sub>2</sub> on mica)	~100	<1	0.90	0.55
Interference violet (TiO <sub>2</sub> on mica)	~100	<1	0.90	0.49
Strontium chromate yellow (SrCrO <sub>4</sub> )	100	<1	0.86	0.38
IR black 799	90	~~12	0.38	0.28
Interference blue (TiO <sub>2</sub> on mica)	80	<1	0.90	0.47
Iron titanium brown spinel (Fe <sub>2</sub> TiO <sub>4</sub> )	80	~3	0.68	0.4
Yellow oxide (FeOOH)	~80	~8	0.56	0.29
Cobalt titanate #2 green spinel	80	~~20	0.40	0.27
Chrome yellow (PbCrO <sub>4</sub> )	70	~1	0.83	0.34

~ indicates that a value is approximate. ~~ indicates that a value is very approximate, usually because the property being characterized varies rapidly over the spectrum of interest.

**Some black and brown pigments.**

Pigment	Absorption strength, 400-700 nm ( $\text{mm}^{-1}$ )	Scattering strength S 700-1200 nm ( $\text{mm}^{-1}$ )	Absorption strength K 700-1200 nm ( $\text{mm}^{-1}$ )	Solar IR reflectance over white	Solar IR reflectance over black
Lamp black (carbon)	>300	~nil	>300	0.04	0.04
Ivory black	200	<1	150		
Copper chromite	~300	~10	~10	0.05	0.06
IR black 797	>300	200	~30	0.46	0.35
IR black 799	~150	90	~12	0.38	0.28
IR black 411	>300	150	~30	0.43	0.33
Iron titanium spinel brown	10 to 100	90	~3	0.68	0.40

**Non-scattering pigments with minimal absorption in the near infrared.**

Pigment	Solar IR reflectance over white	Solar IR reflectance over black	Remarks
Cobalt chromite blue	0.55	0.25	Some scattering. Co ion causes some absorption from 1200 to 1700 nm.
Cobalt aluminate blue	0.62	0.12	Ditto.
Phthalo blue	0.57	0.06	visible absorption extends a bit into the infrared
Phthalo green	0.47	0.08	Ditto
Monstral red	0.86	0.13	Some scattering. Very transparent in IR
Acra burnt orange	0.76	0.08	
Acra red	0.85	0.06	Little scattering. Very transparent in IR
Cerulean blue	0.67	0.18	Some scattering. PB 36, $\text{Co}(\text{Al,Cr})_2\text{O}_4$
Dioxazine purple	0.75	0.06	Very low visible reflectance. Transparent in IR
Napthal red light	0.86	0.20	Poor lightfastness
Azo medium yellow	0.87	0.18	A Hanza yellow, mono-azo, arylide Some scattering. Very transparent in IR
Yellow orange azo	0.86	0.11	Diarylide HR. May fade in tints with white

**Pigments of little value for cool coating formulation (to be used sparingly if at all), due to strong IR absorption.**

Pigment	Estimate of permissible concentration (percent of full masstone), based on $K \times \text{thickness} = 2\%$	Remarks
Raw umber	3%	Broad region of IR absorption
Prussian blue	0.7%	$C_6FeN_6.H_4N$ . Broad IR absorption
Lamp black	< 0.3%	Similar to carbon black
Bone black	0.5%	Bone black is basically a diluted carbon black
$Fe_3O_4$ black	?	This magnetite iron oxide can be present as a contaminant in $Fe_2O_3$ (hematite).
Copper chromite black	~0.5%	
Burnt sienna	10%	Absorption similar to good $Fe_2O_3$ , but less IR scattering