

MASTERBATCHES



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Masterbatches for Injection Moulding



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Introduction

Cabot is a world leader in the manufacture of masterbatches and speciality compounds for the plastics industry, with manufacturing facilities in Belgium, Italy, Hong Kong and the United Arab Emirates. The fully equipped Application Development Centres and extensive Sales Offices ensure that Cabot maintains the highest level of support for its customers.

Cabot's range of **PLASBLAK®**, **PLASWITE®** and **PLASADD®** masterbatches offers a differentiated selection for a wide range of injection moulding applications. Each grade has been specifically designed to meet particular performance criteria as will be explained in the following sections.

Polymer specific and universal masterbatches are included and there is also a range of innovative masterbatches for engineering plastics. End applications include household containers and closures, crates and buckets, toys, as well as automotive and large industrial mouldings.

Each of Cabot's masterbatches for injection moulding is specifically designed in terms of key performance criteria important to injection moulded plastics applications. The key properties common to each masterbatch type are **dilution**, **compatibility** and **dispersion** which are defined as follows:

Dilution: the ease with which the masterbatch mixes with and distributes throughout the fabricator's polymer resin. More details can be found in the Cabot brochure "Dispersion and Dilution".

Compatibility: a measure of the match between the masterbatch carrier and the fabricator's polymer resin.

Dispersion: the extent to which the pigment or additive is wetted out and de-agglomerated within the masterbatch carrier resin. More details can be found in the Cabot brochure "Dispersion and Dilution".

These and other performance criteria are discussed in more depth for each masterbatch type i.e. **black**, **white** and **additive** in the following sections.



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Black Masterbatches

■ Colouration

Colouration is fundamental to the performance of black masterbatches. **Key colouration criteria** can be defined as follows:

Jetness (or masstone): the absorbance of the total visible light by the black coloured moulded plastic part. This can be measured by the L^* value within the CIELAB co-ordinates: the more jet the product, the lower the L^* value. More details can be found in the Cabot brochure “Color Measurement for Carbon Black Filled Plastics”.

Undertone: the blueness/yellowness of the moulded part measured within the CIELAB co-ordinates. A negative b^* value indicates a blue undertone: the more negative the value, the bluer the undertone. More details can be found in the Cabot brochure “Color Measurement for Carbon Black Filled Plastics”.

Gloss: the amount of light reflected by a moulded part: the higher the reflectance, the higher the gloss.

Tinting strength: the ability of the black masterbatch to reduce the amount of reflected light so masking any colour given by the processor’s polymer resin e.g. coloured recyclate. The tinting strength of a black masterbatch can typically be measured from the reflectance of a grey compound after mixing with a white pigment or by the L^* value of the grey compound within the CIELAB co-ordinates.

Fig. 1: Selection of Grades by Colouration

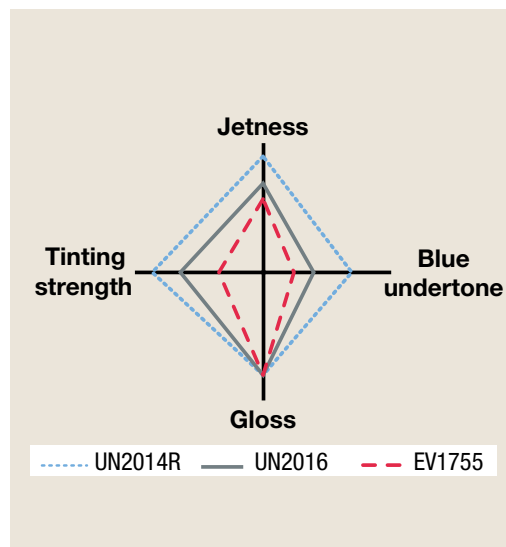
Low colouration, low tint, brown tone, good gloss	Medium colouration, medium tint, good gloss		High colouration high tint, blue tone, good gloss
	Brown tone	Blue tone	
PE2272R	UN2016	PE2813	EG3807
	PS4256		PA3785
EV1755	PS4054		SA3176
	PE4884		UN2014R
	PP6190		

■ Star Diagram showing colouration performance properties of Universal Black Masterbatches

A visual and accessible way to compare different black masterbatches with respect to their colouration properties is the star diagram. This star diagram compares 3 of Cabot’s universal black masterbatches in terms of the 4 key colouration criteria. These comparisons are made for **black** coloured moulded parts.

The 4 criteria are dependent on the type of carbon black present in the masterbatch, whilst gloss is also affected by the masterbatch carrier system which should be as compatible as possible with the polymer resin being moulded. In many applications, it is important to have the desired pigment tone, blue tone often being preferred.

Fig. 2



Performance improves from chart centre

■ Processing

In addition to colouration, there are other important factors to be considered when selecting the most appropriate masterbatch for use in a given application. The processing performance of a masterbatch encompasses the following parameters, the first 3 of which were previously defined on page 2:

- Dilution
- Dispersion
- Compatibility
- Temperature stability

Masterbatch **dilution** is dependent on its viscosity and it is preferable for the melt flow index of the masterbatch to be as near as possible to that of the fabricator's polymer resin. As carbon black severely reduces the flow properties of the masterbatch carrier resin, it is difficult to formulate a black masterbatch with the same melt flow index as the processor's polymer resin; therefore as high a melt flow index black masterbatch as possible should be used for injection moulding.

The masterbatch melt flow index values are shown in figure 3, along with suggested addition rates and specific gravity information.

Fig. 3: Summary of Properties Relevant to Processing

PRODUCT CODE	SUGGESTED ADDITION RATE	MELT FLOW INDEX		SPECIFIC GRAVITY
		%	g/10 min	
UN2014R	1 - 2		27 (21.6kg/190°C)	1.22
UN2016	1 - 2		41 (10kg/190°C)	1.22
EV1755	1 - 3		6 (10kg/190°C)	1.23
EG3807	2 - 4		6.5 (21.6kg/200°C)	1.22
PA3785	1 - 3		7.5 (5kg/250°C)	1.28
SA3176	2		54 (21.6kg/230°C)	1.20
PP6190	2 - 7		9 (5kg/230°C)	1.10
PS4256	2 - 4		38 (10kg/200°C)	1.48
PS4054	1 - 3		6 (5kg/200°C)	1.25
PE4884	1 - 3		5 (10kg/190°C)	1.64
PE2272R	1 - 3		12 (10kg/190°C)	1.23
PE2813	1 - 3		11 (10kg/190°C)	1.05

Dispersion is an inherent property of the pigment and process used to produce the masterbatch. Good dispersion characteristics are particularly important when the end application requires maximum mechanical properties and/or weathering performance.

It is important to have excellent **compatibility** between the masterbatch carrier resin and fabricator's polymer resin particularly in critical applications. Ideally, the carrier resin and polymer resin should be the same but where this is not practical due to the range of resins processed, Cabot's universal masterbatches offer good compatibility with a wide range of polymers.

Temperature stability must be considered when choosing the grade of masterbatch to be used. Figure 4 indicates the typical temperature ranges over which Cabot's black masterbatches for injection moulding should be processed. It may be possible to use processing temperatures outside of the indicated range depending on the masterbatch addition rate and residence time in the injection moulding machine.

Fig. 4: Typical Range of Processing Temperatures (°C)

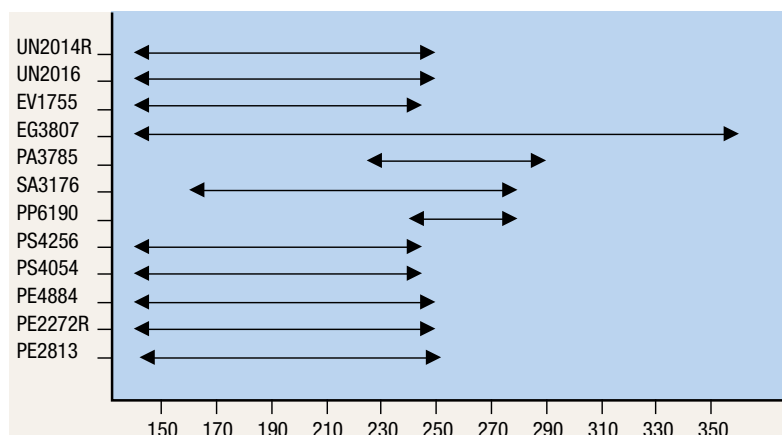


Fig. 5: Effect of masterbatch on Izod Notched Impact strength of HIPS

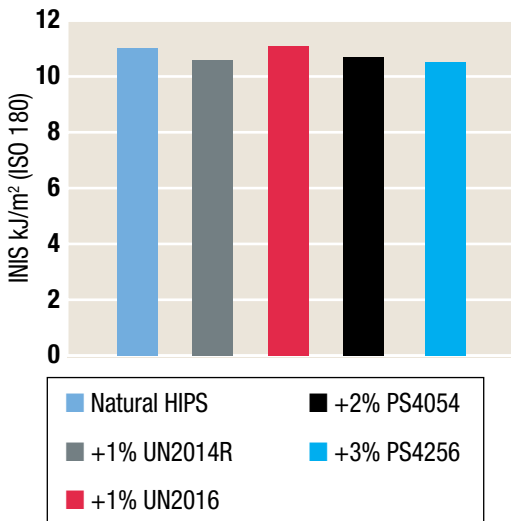
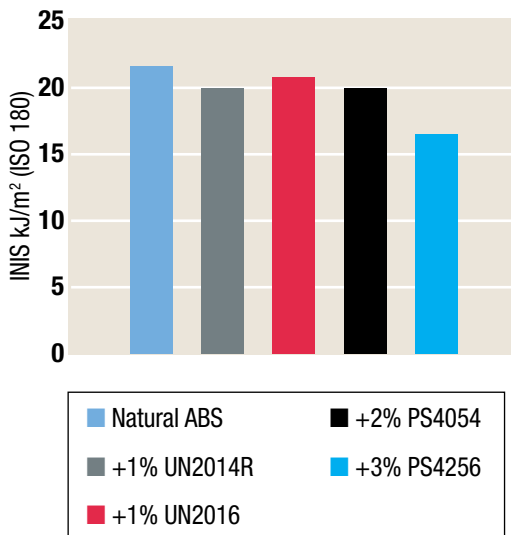


Fig. 6: Effect of masterbatch on Izod Notched Impact strength of ABS



Physical properties

The use of black masterbatches to provide colouration during injection moulding can influence the physical properties of the end product. For example, impact strength of styrenics and engineering polymers can be reduced. The extent to which the physical properties are affected will depend on several factors including:

- Masterbatch addition rate
- Homogeneity of masterbatch in end product (i.e. dilution)
- Dispersion quality of the masterbatch
- Type and level of pigment
- Masterbatch carrier resin

A high quality, high colour strength masterbatch will normally be preferred in applications sensitive to loss of physical properties. Figures 5 and 6 show the effect of some PLASBLAK masterbatches on the impact strength of high impact polystyrene and ABS respectively.



Black Masterbatches for Engineering Thermoplastics

Engineering thermoplastics are particularly important in applications such as automotive, electronics, business machines and domestic appliances due to their superior mechanical properties and high temperature performance. It is essential that the correct masterbatch is selected in order that the maximum performance from the polymer be obtained in the end-product.

It is usual to select a masterbatch, not only with high colouration properties, but with the most compatible carrier system. Often this will be polymer specific to the engineering thermoplastic being processed.

Figure 7 shows Cabot's currently available polymer specific masterbatches for engineering thermoplastics.

To complement these polymer specific masterbatches, Cabot has developed a high performance black masterbatch, **PLASBLAK EG3807**, designed for colouring a wide range of engineering thermoplastics, e.g. polycarbonate, polybutylene terephthalate, polyacetal and polyphenylene sulphide.

Processing properties of Cabot's masterbatches for engineering thermoplastics are summarised in figure 8 below.

Fig. 8: Summary of Properties Relevant to Processing

PRODUCT CODE	SUGGESTED ADDITION RATE	MELT FLOW INDEX	SPECIFIC GRAVITY
	%	g/10 min	
PA3785	1 - 3	7.5 (5kg/250°C)	1.28
SA3176	2	54 (21.6kg/230°C)	1.20
EG3807	2 - 4	6.5 (21.6kg/200°C)	1.22

The use of PLASBLAK EG3807 offers certain performance benefits as follows in engineering thermoplastics:

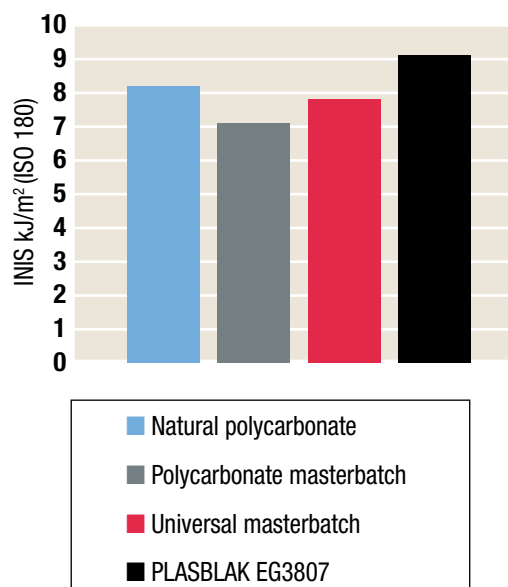
- Suitable for use in a wide range of engineering thermoplastics
- Improved colour generation
- Wide temperature stability
- Wide food contact approval
- Significant improvements in impact properties of some engineering thermoplastics e.g. polycarbonate when used in compounding

Figure 9 demonstrates the advantageous effect of EG3807 compounded into a polycarbonate resin system compared to the natural resin itself and the use of other masterbatches.

Fig. 7: Polymer Specific PLASBLAK Masterbatches for Engineering Thermoplastics

PRODUCT CODE	CARRIER RESIN	COMPATIBLE ENGINEERING THERMOPLASTICS
PA3785	Polyamide 6	Polyamide 6 and 66
SA3176	SAN	SAN/ABS

Fig. 9: Effect of Masterbatch on IZOD Notched Impact Strength of Polycarbonate at 0.7% Carbon Black Versus Natural Polycarbonate (kJ/m²)



White Masterbatches

Cabot's PLASWITE masterbatches for injection moulding offer excellent pigmentation characteristics and easy processability across a wide range of polymers.

Basic processing properties of these grades are summarised in figure 10.

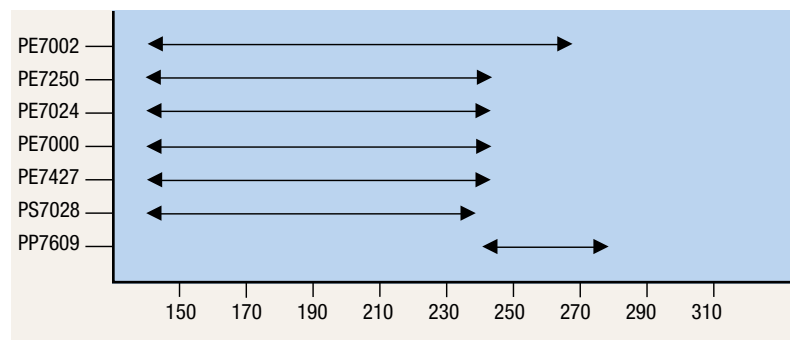
Fig. 10: Summary of Properties Relevant to Processing

PRODUCT CODE	SUGGESTED ADDITION RATE	MELT FLOW INDEX		SPECIFIC GRAVITY
	%	g/10 min		g/cm ³
PE7002	1 - 2	12	(2.16kg/190°C)	2.18
PE7250	1 - 2	45	(2.16kg/190°C)	2.00
PE7024	1 - 2	16	(2.16kg/190°C)	1.71
PE7000	1 - 2	15	(2.16kg/190°C)	2.21
PE7427	2 - 4	20	(2.16kg/190°C)	2.15
PS7028	1 - 2	46	(5.0kg/200°C)	1.88
PP7609	2 - 4	15	(2.16kg/230°C)	1.48

Figure 11 shows the typical range of processing temperatures recommended for each PLASWITE masterbatch for injection moulding.

As with the PLASBLAK masterbatches, it may be possible to use processing temperatures outside of the indicated range depending on the masterbatch addition rate and residence time in the injection moulding machine.

Fig. 11: Typical Range of Processing Temperatures (°C)



Additive Masterbatches

Cabot's range of PLASADD masterbatches for injection moulding have different functions designed to enhance the performance characteristics of injection moulded articles and/or improve processing properties.

Basic processing properties of these grades are summarised in figure 12.

Fig. 12: Summary of Properties Relevant to Processing

PRODUCT CODE	SUGGESTED ADDITION RATE	MELT FLOW INDEX	SPECIFIC GRAVITY
	%	g/10 min	g/cm ³
PE9041	1 - 2	15 (2.16kg/190°C)	0.91
PE9247	0.5 - 2	38 (2.16kg/190°C)	0.94
PE8999	1 - 3	16 (2.16kg/190°C)	1.29

* addition rate will depend on the specific application and requirements which should be discussed with a Cabot representative.

■ Mould release agent masterbatch: PLASADD PE9041

When moulding intricate plastic parts or articles with a large surface area, mouldings can fail to eject from the mould. To overcome this problem, mould release agents are used. They can be external additives such as silicone sprays or they can be internal additives such as those provided by PE9041.

Figures 13 and 14 demonstrate the benefits of adding PE9041 to polypropylene and high density polyethylene respectively at 1.25%. Reductions of approximately 20% in the cooling cycle were recorded during injection moulding of a PP wheel using a 4 cavity mould and approximately 20% in the second stage pressure holding time during injection moulding of an HDPE wheel.

Fig. 13: Mould Release Trials Using 1.25% PE9041 in Polypropylene

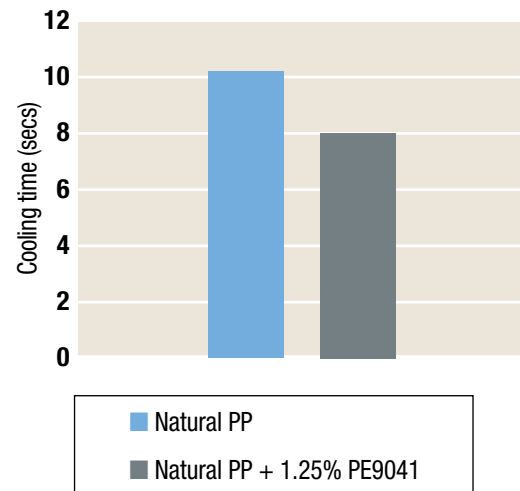


Fig. 14: Mould Release Trials Using 1.25% PE9041 in High Density Polyethylene

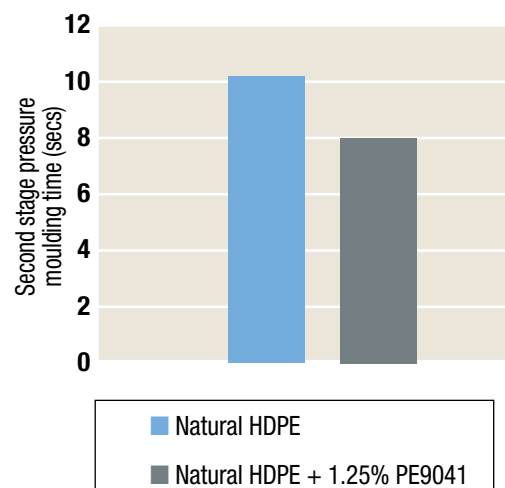
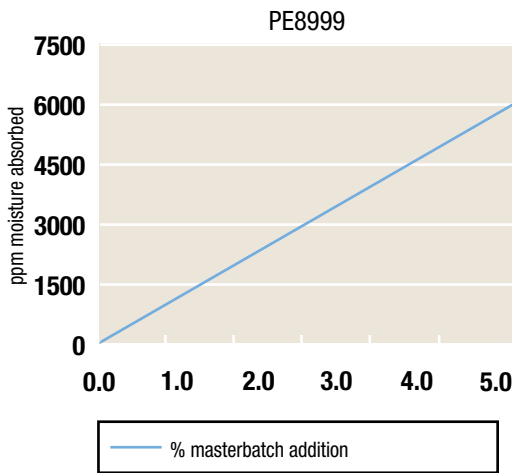


Fig. 15: Moisture Absorption versus Desiccant Masterbatch Addition Rate



It should be noted that high levels of desiccant masterbatch could have a detrimental effect on the surface smoothness of the moulded parts.

■ Desiccant masterbatch: PLASADD PE8999

The presence of moisture in raw materials can have a number of undesirable effects that can lead to increased scrap levels and loss of production. Common effects during injection moulding include porosity and surface imperfections as well as the emission of excessive amounts of volatiles from the nozzle of the moulding machine. The use of desiccants is therefore an important consideration for processors using recycled materials in ensuring that production efficiency and product quality are maintained.

Cabot's desiccant masterbatch incorporates additives which chemically bond with the moisture, a process which is irreversible at all temperatures used in plastics processing. The masterbatch will absorb 1500 ppm of moisture for every 1% added.

PLASADD PE8999 contains a desiccant additive in an LDPE carrier and is suitable for use in the injection moulding of recycled polyethylene and polypropylene.



Grade Summary

PRODUCT CODE	DESCRIPTION	PE	PP	PS	ABS	SAN	PA	PC	PET	Other engineering polymers*
PLASBLAK MASTERBATCHES										
UN2014R	Premium jet black universal	++	++	++	++	++	+	+		
UN2016	Medium colour universal	++	++	++	++	++	+	+		
EV1755	Universal black masterbatch	++	++	++	++	++	+	+		
EG3807	High performance jet black masterbatch for engineering polymers				+	+	++	++		++
PA3785	Black masterbatch for nylon						++			
SA3176	Black masterbatch for ABS/SAN			++	++	++				
PP6190	Premium black masterbatch for PP weathering applications based on copolymer		++							
PP3393	Black masterbatch for PP		++							
PS4054	Premium black masterbatch for styrenics			++	+	+				
PS4256	Economy black masterbatch for styrenics			++	+	+				
PE4884	Economy black masterbatch for polyolefins	++	++							
PE2272R	General purpose black masterbatch	++	++							
PE2813	FDA compliant black masterbatch	++	++							
PLASWITE MASTERBATCHES										
PE7002	Universal 75% white	++	++	++	++	++	+	+		
PE7024	Premium 60% white for polyolefins	++	++	++	++	++	+	+		
PE7250	Premium 70% white for polyolefins with outstanding pigmentation	++	++							
PE7000	Utility 50% white for polyolefins	++	++							
PE7427	Utility 40% white for polyolefins	++	++							
PS7028	60% white for styrenics			++	++	++				
PP7609	55% white for PP		++							
PLASADD MASTERBATCHES										
PE9041	Mould release agent	++	++							
PE8999	Desiccant for polyolefins	++	++							

Key:
 ++ suitable
 + limited suitability
 * PBT, PMMA, POM, PPS

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