P-802 nanoMax® Polyolefin Masterbatch Products

General Description:

nanoMax® is a series of Nanomer-polyolefin resin masterbatch products. They are the first nanoclay products to feature a convenient pellet form. These masterbatch products are produced through melt compounding based on patented technologies (US **6,462,122 and 6,632,868**). They include all compatibilizers needed to promote complete nanoclay dispersion. Typical of masterbatches, nanoMax products offer excellent processability and can be used in a wide variety of equipment, including extruders, mixers, and even injection molders.

Each nanoMax grade contains 50 wt% Nanomer® nanoclay. Addition of nanoMax into polyolefin improves mechanical performance properties and flame resistance. Effectiveness of nanoclay added via nanoMax is similar to well dispersed nanoclay in polyolefin resins. Letdown levels are commonly in the range of 8-12 wt% nanoMax for mechanical improvement, and 2-8 wt% for flame retardation. nanoMax masterbatch products are very effective in flame retardation when combined with traditional flame retardants.

Product Information:

nanoMax masterbatch products are available in several carrier resins: PP, TPO, PEs and EVA. The EVA and PEs grades are designed mainly for flame retardation applications. PP and TPO grades can be used to boost mechanical properties as well as flame retardation applications. For PP and TPO FR compounds, nanoMax-PP-nH is designed for non-halogen systems such as Mg(OH)2 systems only. The TPO grade includes a special impact modifier, which improves stiffness while at the same time maintains high impact strength, even at low temperatures. nanoMax-PP-HiST can be used to formulate high impact and high stiffness PP compounds.

Table 1. Nanomer® Products for Polyolefin Nanocomposites

Grade	Applicable Resins	Mechanical	Impact	Flame Retardation
nanoMax®-PP	PP, TPO	Yes	n/a	Br or APP systems
nanoMax®-PP-nH	PP, TPO	n/a	n/a	MDH systems
nanoMax®-PP-HiST	PP, TPO	Yes	Yes	Br or APP systems
nanoMax®-TPO	TPO	Yes	Yes	Br or APP systems
nanoMax®-HDPE	HDPE	Yes	n/a	MDH, ATH systems
nanoMax®-LDPE	LDPE	Yes	n/a	MDH, ATH systems
nanoMax®-LLDPE	LLDPE	Yes	n/a	MDH, ATH systems
nanoMax®-EVA	EVA, LDPE	n/a	n/a	MDH, ATH systems

Product Characteristics:

nanoMax products are in a dust-free pellet form. Each standard package contains 10-kg of product. Nanocor can also pack products in bulk bags and paper board drums upon customer request.

Processing Recommendations:

nanoMax masterbatches can be processed in common equipment to achieve nanoclay dispersion. No additional compatiblizer is needed in the processing step. For highly filled resin systems, such as $Mg(OH)_2$ filled FR system, we recommend using a twin screw extruder to disperse the masterbatch into the final formulations. For some applications, nanoMax masterbatch products can be dry mixed with the resin in the injection molding stage. For detailed nanoMax processing guidelines, please refer to Nanocor Technical Data Sheets P-804. .

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Performance Properties:

Low addition levels of Nanomer nanoclays create significant improvement in mechanical properties. Table 2 reports the mechanical performance data on nanoMax-TPO and nanoMax-PP, which were incorporated into PP and TPO matrices. In the TPO formulation, a reactor grade TPO was used for both control and nano-filled formulations. As the table indicates, Nanomers increase stiffness and heat stability while maintaining impact strength. Our study results show that nanoclay in the nanoMax formulation is equivalent to nanoclay which is incorporated by direct compounding process.

Table 2. Mechanical Properties - Homo-PP and TPO with 6 wt% Nanomer® Loading

Sample	nanoMax Loading %	Resin	Flexural Strength (MPa)	Flexural Modulus (MPa)	Improvement (%)	HDT (C)
Control	0	TPO	22	820	/	73
I.44P*	nanoMax-TPO 12%	TPO	30	1300	60%	93
Control	0	HPP	35	1180	/	88
I.44P	nanoMax-PP 12%	HPP	46	1780	50%	109

nanoMax-PP was also incorporated into a brominated FR system through compounding. Table 3 lists the performance of this FR combination. Formula 2 provides an example of the mechanical benefit for Nanomer incorporation while improving the FR rating from V-1 to V-0 in UL94 testing. Formulas 3 and 4 provide information on the reduction of brominated compounds, while maintaining V-0 and mechanical properties. One will also observe significant reduction in blooming of brominated compounds in the nanocomposite formulation using accelerated heat aging tests.

Table 3. Flame Retardation of Brominated Compounds and Nanomer Combination

Components	Formula 1	Formula 2	Formula 3	Formula 4
DECA (wt%)	25	25	22	22
ATO (wt%)	6	6	6	6
nanoMax-PP (wt%)	0	12	8	12
UL-94 rating	V1	V-0	V-0	V-0
Flex Strength (MPa)	46	51	52	53
Flex Modulus (MPa)	1810	2570	2490	2740

nanoMax-EVA was incorporated into a non-Hal FR compound using EVA as the matrix resin. In a typical $Mg(OH)_2$ filled system, 65wt% $Mg(OH)_2$ is needed to achieve a V-0 rating. For such a highly filled system, it is difficult to achieve filler dispersion and processing speeds are significantly reduced for downstream fabrication due to surface defects. Formulas 3 and 4 demonstrate the benefit of Nanomer in this FR formulation. Simply by incorporating of just 6% nanoMax-EVA, $Mg(OH)_2$ can be reduced to 60% and 55% respectively while simultaneously maintaining the fire rating and increasing fabrication speeds.

Table 4. Flame Retardation of $Mg(OH)_2$ and Nanomer Combinations

Components	Formula 1	Formula 2	Formula 3	Formula 4
EVA (wt%)	35	40	37	42
$Mg(OH)_2$ (wt%)	65	60	60	55
nanoMax-EVA (wt%)	0	0	3	6
UL-94 rating (1/8)	V-0	Fail	V-0	V-0

It is believed that Nanomers function as anti-dripping agents in FR systems, thereby improving fire ratings. There are also reports indicating nanoclays function as char forming agents during the combustion process.

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