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(72) Inventeurs/Inventors:  
MATSUE, KENJI, JP;  
NISHIOKA, NAGANORI, JP  
(73) Propriétaire/Owner:  
DDP SPECIALTY ELECTRONIC MATERIALS US, INC.,  
US  
(74) Agent: SMART & BIGGAR LLP

(54) Titre : COMPOSITION POUR MOUSSE POLYMERE COMPRENANT UN POLYMERE STYRENIQUE, UNE CIRE  
POLYETHYLENE ET UN COPOLYMER VINYLE AROMATIQUE/BUTADIENE BROME  
(54) Title: COMPOSITION FOR POLYMERIC FOAM COMPRISING STYRENIC POLYMER, POLYETHYLENE WAX AND  
BROMINATED VINYLAROMATIC/BUTADIEN- COPOLYMER

(57) **Abrégé/Abstract:**

A polymer composition containing a polymer component containing styrenic polymer, a brominated vinyl aromatic / butadiene copolymer and a polyethylene wax, concentration of the polyethylene wax is 0.02 to 1.0 weight percent based on weight of the polymer component, the polyethylene wax has average molecular weight of 10,000 g/mol or less than 10,000 g/mol. The polymer composition can be a polymeric foam.

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## (71) Applicant: DOW GLOBAL TECHNOLOGIES LLC

[US/US]; 2040 Dow Center, Midland, MI 48674 (US).

## (72) Inventors: MATSUE, Kenji; 248-6 Hyogotsuka-machi, Utsunomiya-Shi, Tochigi 321-0156 (JP). NISHIOKA, Naganori; Sun-Green Takinohara 203, 1-3-1, Takinohara, Utsunomiya-Shi, Tochigi 320-0846 (JP).

## (74) Agent: MORK, Steven W.; The Dow Chemical Company, Intellectual Property, P. O. Box 1967, Midland, MI 48641-1967 (US).

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(57) Abstract: A polymer composition containing a polymer component containing styrenic polymer, a brominated vinyl aromatic / butadiene copolymer and a polyethylene wax, concentration of the polyethylene wax is 0.02 to 1.0 weight percent based on weight of the polymer component, the polyethylene wax has average molecular weight of 10,000 g/mol or less than 10,000 g/mol. The polymer composition can be a polymeric foam.



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**COMPOSITION FOR POLYMERIC FOAM COMPRISING STYRENIC POLYMER, POLYETHYLENE WAX  
AND BROMINATED VINYLAROMATIC/BUTADIENE- COPOLYMER**

**TECHNICAL FIELD**

This invention relates to styrenic polymeric compositions comprising polyethylene  
5 wax and a brominated vinyl aromatic/butadiene copolymer, polymeric foams containing  
such compositions and a process for preparing such foam.

**BACKGROUND**

To make a styrenic polymer foam, conventional low molecular weight brominated  
10 compound such as hexabromocyclododecane (HBCD) is typically used as a flame retardant.  
However, HBCD is facing governmental regulation over environmental concerns. Therefore,  
there is a need for an alternative flame retardant for use in styrenic foam.

US patent application US2008/0287559A discloses the use of a brominated vinyl  
aromatic / butadiene copolymer as an alternative flame retardant to HBCD in styrenic foam.  
15 A challenge with using the brominated vinyl aromatic / butadiene copolymer is that it tends  
to nucleate cell growth during foaming to a larger degree than HBCD due to the dispersed  
particulate nature of the brominated vinyl aromatic / butadiene copolymer in the polystyrene  
matrix. As a result an undesired amount of nucleation can occur in polystyrene foam, which  
produces a greater number of cells, smaller cells and a higher density foam than foam made  
20 using HBCD.

US patent US4,229,396 discloses natural and synthetic waxes as a cell size enlarger  
of an alkenyl aromatic resin. However, there is no suggestion that polyethylene wax is able  
to effectively work to produce larger cells in the presence of particulates by counteracting  
the nucleating effect of the particles (such as brominated vinyl aromatic/butadiene  
25 copolymer particles) during the formation of a styrenic polymer foam.

Additives such as cell size enlarger affect not only cell size and density of a  
polymeric foam but also other properties of a polymeric composition or a polymeric foam.  
It causes difficulty in forming a polymeric foam. For example, during forming a polymeric

foam by extruder, output speed of a foam is affected by the properties of a polymeric composition such as smoothness of the surface of the composition. Less smoothness leads hardness of extrusion, but extreme smoothness leads slip of composition and decrease the speed of extrusion. The slip of composition causes the decline of productivity and deterioration of the obtained foam. Therefore, the combination of flame retardant and additives which shows required properties for polymeric composition and polymeric foam is important.

It is desirable to find an additive that would allow preparation of HBCD-free styrenic polymer foam comprising brominated vinyl aromatic / butadiene copolymer that has a larger cell size and lower density than a comparable styrenic polymer foam prepared in the absence of the additive. It is particularly desirable to prepare such a foam where the cell size is at least as large as comparable HBCD-containing styrenic polymer foam and the density as at least as low as a comparable HBCD-containing styrenic polymer foam, without affecting smoothness of a surface of a polymeric composition.

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## SUMMARY OF THE INVENTION

The present invention is made in view of the above-mentioned problems, and provides a solution to the problem of finding an additive that would allow preparation of HBCD-free styrenic polymer foam comprising brominated vinyl aromatic / butadiene copolymer that has a larger cell size and lower density than comparable styrenic polymer foam prepared in the absence of the additive, without affecting smoothness of a surface of a polymeric composition.

A first aspect of the present invention is a polymer composition comprising a polymer component comprising styrenic polymer, a brominated vinyl aromatic / butadiene copolymer and a polyethylene wax at a concentration of 0.02 to 1.0 weight percent based on weight of polymer component, wherein an average molecular weight of the polyethylene wax is 10,000 grams per mole (g/mol) or less than 10,000 g/mol. In a desirably embodiment,

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the polymer composition is a polymeric foam where the polymer component has cells defined therein.

In an embodiment, the present invention relates to a polymer composition comprising a polymer component comprising styrenic polymer, a brominated vinyl aromatic/butadiene copolymer and a polyethylene wax, concentration of the polyethylene wax is 0.02 to 1.0 weight percent based on weight of the polymer component, and the weight average molecular weight of the polyethylene wax is 10,000 g/mol or less and wherein the styrenic polymer is any one or more than one polymer selected from the group consisting of homopolymer of styrenic monomer and copolymers containing copolymerized styrenic monomer and monomers including any one or combination of more than one monomer selected from the group consisting of methyl, styrene, dimethyl styrene, ethyl styrene, diethyl styrene, isopropyl styrene, chloro styrene, dichloro styrene, trichloro styrene, vinyl toluene, vinyl xylene, divinyl benzene, acrylic acid, methacrylic acid, methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, acrylonitrile, maleic anhydride and itaconic anhydride.

A second aspect of the present invention is a process for preparing the foam of the particularly desirably embodiment of the first aspect.

In an embodiment, the present invention relates to a process for preparing the polymeric composition described herein, when the composition is an extruded polymer foam, the process comprising: (a) melt blending the polymer component with the brominated vinyl aromatic/butadiene copolymer, polyethylene wax and a blowing agent to form a foamable polymer composition; and (b) expanding the foamable polymer composition into a polymeric foam.

#### EFFECT OF THE INVENTION

The present invention provides a solution to the problem of finding an additive that would allow preparation of HBCD-free styrenic polymer foam comprising brominated vinyl aromatic/butadiene copolymer that has a larger cell size and lower density than

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comparable styrenic polymer foam prepared in the absence of the additive. Moreover, the present invention is capable further solving the problems of preparing such foam where the cell size is at least as large as comparative HBCD-containing styrenic polymer foam, without affecting smoothness of a surface of a polymeric composition. The foam of the first aspect is

5 useful for many foam application including thermal insulation.

#### Description of Embodiments

Test methods refer to the most recent test method as of the priority date of this document when a date is not indicated with the test method number. References to test methods contain both a reference to the testing society and the test method number. The

10 following test method abbreviations and identifies apply herein: JIS refers to Japanese Industrial Standard; ASTM refers to American Society for Testing and Materials; EN refers to European Norm, DIN refers Deutches Institute fur Normung; and ISO refers to International Organization for Standards.

"Multiple" means two or more. "And/or" means "and, or as an alternative". All

15 ranges include endpoints unless otherwise indicated.

"Copolymer" refers to any combination of more than one monomer co-reacted to form a polymer. Copolymer can be random copolymers or block copolymers. Block copolymers can be of any type including diblock and triblock copolymers.

The polymer composition and polymeric foam of the present invention comprising a polymer component comprising styrenic polymer, a brominated vinyl aromatic / butadiene copolymer and a polyethylene wax.

(A) Styrenic polymer

5 The styrenic polymer can be any one or more than one polymer selected from homopolymers of styrenic monomers and copolymers containing copolymerized styrenic monomer. Polystyrene homopolymer is the most preferable styrenic polymer for use in the present invention.

10 Examples of monomers which can be copolymerized with styrenic monomer to form suitable styrenic polymers for use in the present invention include any one or combination of more than one monomer selected from: styrene derivatives such as methyl styrene, dimethyl styrene, ethyl styrene, diethyl styrene, isopropyl styrene, bromo styrene, dibromo styrene, tribromo styrene, chloro styrene dichloro styrene or trichloro styrene; vinyl compounds such as vinyl toluene, vinyl xylene or divinyl benzene; unsaturated  
15 compounds such as acrylic acid, methacrylic acid, methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butadiene or acrylonitrile, or derivatives thereof; maleic anhydride and itaconic anhydride.

The styrenic polymer is preferably more than 50 weight-percent (wt%), more preferably 75 wt% or more and can be 90 wt% or more, 95 wt% or more and even 100 wt%  
20 based on the polymer component weight.

(B) Brominated vinyl aromatic / butadiene copolymer

The flame retardant used in the present invention is a brominated vinyl aromatic / butadiene copolymer. Preferably, the brominated vinyl aromatic / butadiene copolymer is brominated styrene / butadiene copolymer because flame retardant effect of the brominated  
25 styrene / butadiene copolymer is greater. The brominated styrene/butadiene copolymer includes brominated styrene/butadiene block copolymer, brominated random styrene/butadiene copolymer and brominated styrene/butadiene graft copolymer. Brominated tri-block brominated vinyl aromatic/butadiene copolymer such as brominated

styrene/butadiene/styrene block copolymer is more preferable. The brominated vinyl aromatic/butadiene copolymer is desirably one or more brominated butadiene/vinyl aromatic copolymer selected from those described and/or claimed in EP1957544B1.

The concentration of brominated vinyl aromatic/butadiene copolymer is desirably  
5 0.25 wt% or more and generally 70 wt% or less based on weight of polymer component. The concentration of brominated vinyl aromatic/butadiene copolymer is preferably 1.0 wt% or more and 6.0 wt% or less, most preferably 2.0 wt% or more and 4.0 wt% or less based on weight of polymer component. At concentrations below 0.25 wt% the brominated vinyl aromatic/butadiene copolymer is generally not present at a high enough concentration to  
10 improve flame retardant properties of the polymer composition to a desirable extent. At concentrations above 70 wt%, the brominated vinyl aromatic/butadiene copolymer is at such a high concentration so as to often make processing difficult.

When the polymer composition is in the form of polymeric foam, the concentration of brominated vinyl aromatic/butadiene copolymer is desirably 0.25 wt% or  
15 more, preferably 1.0 wt% or more and more preferably 2.0 wt% or more at the same time desirably is 10 wt% or less, preferably 6 wt% or less, and more preferably 4 wt% or less based on weight of polymer component.

#### (C) Polyethylene wax

The polyethylene wax used in the present invention can be a degraded wax, which  
20 is obtained by degradation of polyethylene, and an oxidized polyethylene wax, and is preferably a polyethylene wax polymerized by Ziegler catalyst. In the present invention, the average molecular weight of the polyethylene wax is 10,000 g/mol or less, preferably 6,000 g/mol or less, more preferably 500 g/mol to 6,000 g/mol. If the average molecular weight is more than 10,000 g/mol, the effect of cell size enlargement is low. The average molecular



weight of the polyethylene wax is normally determined by GPC as compared to a polystyrene standards.

In addition, it is surprising that the polyethylene wax having 10,000 g/mol or less than 10,000 g/mol of average molecular weight does not decrease extruder screw loading of an extruder during forming a polymeric foam. Extruder screw loading is a barometer of the smoothness of a surface of a polymeric composition. Less smoothness leads difficulty of extrusion, but extreme smoothness leads slip of composition and decrease the productivity and deterioration of the obtained foam. Although waxes are known as a lubricating agents, the inventors found the polyethylene wax having 10,000 g/mol or less than 10,000 g/mol of average molecular weight does not decrease extruder screw loading of an extruder during forming a polymeric foam.

In the present invention, the concentration of a polyethylene wax is 0.02 to 1.0 wt% and preferably 0.03 to 0.7 wt% based on weight of polymer component. When the amount of a polyethylene wax is less than 0.02 wt%, the effect of enlarging cell sizes is low.

#### (D) Other additives

In the present invention, the polymeric composition could further comprise other additives. Examples of other additives include stabilizers for a flame retardant, extrusion aids, pigment and inorganic fillers. Examples of stabilizer include magnesium oxide, epoxy resin, phosphate and epoxidized soybean oil. Examples of extrusion aids include metal salts of stearic acid such as barium stearate.

The polymeric foam of the present invention surprisingly has a cell size that is larger than a comparable foam without the polyethylene wax. Moreover, the polymeric foam of the present invention tends to have a cell size equal to or greater than a comparable foam comprising an equal amount HBCD instead of brominated alkyl aromatic/butadiene copolymer. The polymeric foam of the present invention desirably has an average cell size

(“cell size”) that is 0.1 millimeters (mm) or more and at the same time that is desirably 4.0 mm or less, preferably one mm or less, still more preferably 0.8 mm or less. Determine cell size according to ASTM method D-3576-04.

The polymeric foam can be either an open cell foam or a closed cell foam.

- 5 Desirably, the styrenic polymer foam has an open cell content of 30 percent (%) or less, preferably 10% or less, still more preferably 5% or less, even more preferably one % or less and can be zero %. Determine open cell content according to ASTM method D6226-05. Open cell foams can contain greater than 30% open cell content.

- Desirably, the polymeric foam has a density of 24 kilograms per cubic meter  
10 (kg/m<sup>3</sup>) or more and at the same time desirably has a density of 80 kilograms per cubic meter (kg/m<sup>3</sup>) or less, preferably 48 kg/m<sup>3</sup> or less. Determine density of the styrenic polymer by the following formula, [Density] = [weight of foam] / [volume of foam]. The volume of foam is determined from a water quantity removed when the foam is submerged. It is desirable to have a density of 24 kg/m<sup>3</sup> or more in order to ensure structural integrity.  
15 It is desirably to have a density of 80 kg/m<sup>3</sup> or less, especially 48 kg/m<sup>3</sup> or less for optimal thermal insulating properties.

- Prepare the polymeric foam of the present invention by any foaming method suitable for preparing polymeric foam. In general the process for preparing the polymeric foam comprises: (a) melt blending the polymeric component with the brominated vinyl  
20 aromatic/butadiene copolymer, polyethylene wax and a blowing agent to form a foamable polymer composition; and (b) expanding the foamable polymer composition into polymeric foam. The blowing agent could be incorporated into the polymer component separately from other ingredients of the polymeric component. When additional additives are present, they are typically melt blended in to foam the foamable polymer composition in step (a).

Foaming process can be either batch or continuous processes. An example of a process suitable for the present invention is; blending the polymeric component with brominated vinyl aromatic/butadiene copolymer and other ingredients excepting blowing agent, adding forming agent to the above blended composition at a pressure of 110 to 200 kg/cm<sup>2</sup> followed by melt blending the all component in an extruder, cooling the melt blended component uniformly, and expanding the cooled composition through a die into an atmosphere pressure to form a foamable polymeric composition.

The melting temperature of melt blending the polymeric component with other ingredients is 160 to 240°C, preferably 170 to 230 °C, and more preferably 180 to 220°C. When blowing agent is pressed into polymeric composition, the pressure of pressed in the extruder is 110 to 200 kg/cm<sup>2</sup>, and more preferably 120 to 185 kg/cm<sup>2</sup>. The solid ingredients melted by the extruder and the blowing agents are mixed by a mixer (extruder speed: 20 to 40 rpm, more preferably 25 to 35 rpm), and slowly cooled by a cooler. The optimum temperature when the melt blended composition is cooled and foamed is 100 to 130°C, and more preferably 110 to 127°C.

The blowing agent is typically selected from organic blowing agents, inorganic blowing agents and chemical blowing agents. Desirably, the blowing agent comprises or consists of one or more than one saturated hydrocarbon having 3 to 5 carbon atoms.

Examples of saturated hydrocarbon having 3 to 5 of carbon atoms are: propane, normal-butane, iso-butane, industrial butane (mixture of normal-butane and iso-butane), normal-pentane, iso-pentane, cyclopentane and neopentane. Preferable hydrocarbon having 3 to 5 carbon atoms is normal-butane or iso-butane because of blowing effect and insulating effect of obtained foam. The most preferable hydrocarbon having 3 to 5 carbon atoms is iso-butane. The concentration of saturated hydrocarbon having 3 to 5 carbon atoms is preferably 1 to 10 parts by weight based on 100 parts by weight of styrenic polymer, more

preferably, 1.5 to 5 parts by weight based on 100 parts styrenic polymer in order to obtain both quality insulating effect and flame retardant effect.

Examples of other organic blowing agents include: alkyl chlorides such as methyl chloride or ethyl chloride; ethers such as dimethyl ether, diethyl ether, methyl ethyl ether, isopropyl ether, normal butyl ether, di-isopropyl ether, furan, furfural, 2-methyl furan, tetrahydrofuran or tetrahydropyran; ketones such as dimethyl ketone, methyl ethyl ketone, diethyl ketone, methyl normal-propyl ketone, methyl normal-butyl ketone, methyl iso-butyl ketone, methyl normal-amyl ketone, methyl normal-hexyl ketone, ethyl normal-propyl ketone or ethyl normal-butyl ketone; alcohols such as methanol, ethanol, normal-propanol, iso-propanol, normal-butanol, iso-butanol or tertiary-butanol; and carbonic esters such as methyl formate, ethyl formate, propyl formate, butyl formate, amyl formate, methyl propionate or ethyl propionate.

Examples of inorganic blowing agents include carbon dioxide and water. Example of chemical blowing agents include azo compound. These blowing agents could be used alone or as a mixture of more than two blowing agents. Suitable other blowing agents include methyl chloride, ethyl chloride and dimethyl ether.

The total concentration of blowing agents is, preferably, 0.5 to 20 wt% based on weight of polymeric component.

#### Examples

##### Examples 1 to 3 and Comparative Examples A and B

The polymer composition was polystyrene homopolymer with a weight average molecular weight of 210,000 g/mol. The brominated alkyl aromatic/butadiene copolymer was a brominated styrene/butadiene/styrene block copolymer that is 64 wt% bromine and that has a softening point of 120 degrees Celsius (°C), molecular weight of 100,000-160,000 g/mol and a 5% weight loss temperature by thermogravimetric analysis of 262°C (Br-SBC, for example EMERALD INNOVATION™ 3000, EMERALD INNOVATION is a

trademark of Chemtura Corporation). Polyethylene wax was polyethylene wax with a weight average molecular weight of 6,000 g/mol (LICOWAX™ PE520 supplied from Clariant Corporation).

For Examples (Ex) 1 through 3 and Comparative Examples (Comp Ex) A, use the  
5 brominated alkyl aromatic / butadiene copolymer as a flame retardant additive at a concentration of 2.85 wt% based on polystyrene homopolymer weight. For Exs 1 through 3, further include 0.05, 0.20 and 0.40 wt% polyethylene wax respectively based on weight of polystyrene homopolymer.

Comp Ex B includes hexabromocyclododecane (HBCD) as a flame retardant  
10 additive at 2.5 wt% based on polystyrene homopolymer weight in place of the brominated alkyl aromatic / butadiene copolymer and does not include any polyethylene wax.

For Ex 1 through 3, feed polystyrene homopolymer, brominated styrene/butadiene/styrene block copolymer, polyethylene wax along with remaining additives as identified in Table 1 into a hopper of an extruder with four heating zones, a  
15 blowing agent mixing section, cooler section with three heating zones and adjustable slit die. Melt blend the components in the extruder with the four heating zones set at 110°C, 140°C, 185°C and 200°C respectively. Inject a blowing agent composition (carbon dioxide, Industrial butane (35/65 mix of isobutene/normal butane), and ethyl chloride at ratios in Table 1) into the mixture in the blowing agent mixing section to form a foamable polymer  
20 composition. Mix the foamable polymer composition, then feed into the cooler section set at 140°C, 135°C and 125°C respectively. Cool the foamable polymer composition uniformly and extrude through a slit die set at 100°C into atmospheric pressure and allow to expand into polymeric foam. Additives used in Ex 1 are; an epoxy cresol novolac resin (CN type resin, Product name is ARALDITE ECN1280, supplied from Huntsman Japan), a phosphate  
25 (DOVERPHOS S-9228, supplied from Dover Chemical Corporation) and an epoxidized soybean oil (Plas-Check 775, supplied from Ferro Corporation) as stabilizers, barium stearate as a lubricating agent and phthalocyanine blue as a colorant.

Prepare Comp Ex A in like manner as Example 1-3 except do not include the polyethylene wax.

Prepare Comp Ex B in like manner as Example 1-3 except do not include either of the polyethylene wax and brominated styrene/butadiene/styrene block copolymer and  
5 instead includes HBCD as a flame retardant. As stabilizer, magnesium oxide is used instead of epoxy cresol novolac resin, phosphate and epoxidized soybean oil.

Determine density of the styrenic polymer by the following formula, [Density] = [weight of foam] / [volume of foam]. The volume of foam is determined from a water quantity removed when the foam is submerged. The average cell size diameter is  
10 determined by average value of thickness, width and length directions of cell size according to ASTM method D 3576. The results are shown in Table 1.

The foam characteristics reveal that Polyethylene wax effectively counteracted the nucleating effect of Br-SBC (compare Ex 1-3 to Comp Ex A) and to such an effect as to even produce a foam having a larger cell size than foam made using HBCD (compare Ex  
15 1-3 to Comp Ex B).

Table 1

		Ex 1	Ex 2	Ex 3	Comp Ex A	Comp Ex B
Flame retardant	Br-SBC	2.8	2.8	2.8	2.8	-
	HBCD	-	-	-	-	2.5
	Bromine content	1.9	1.9	1.9	1.9	1.9
Stabilizer	CN type epoxy resin	0.48	0.48	0.48	0.48	-
	Phosphate	0.28	0.28	0.28	0.28	-
	Epoxidized soybean oil	0.24	0.24	0.24	0.24	-
	Magnesium oxide	-	-	-	-	0.03
Polyethylene wax	Licowax PE520	0.05	0.20	0.40	-	-
Lubricating agent	Barium stearate	0.10	0.10	0.10	0.10	0.07
Colorant	Phthalocyanine blue	0.10	0.10	0.10	0.10	0.10
Blowing agent	Industrial butane	2.0	1.9	2.0	1.9	2.0
	Ethyl chloride	4.0	3.9	4.0	3.9	4.0
	Carbonic dioxide	2.7	2.6	2.7	2.6	2.7
Characteristics of foam	Density without skins ( $\text{kg/m}^3$ )	37	38	38	38	37
	Average cell size diameter (millimeters)	0.43	0.51	0.65	0.21	0.45

In table 1, unit of each number for ingredients (flame retardant, stabilizer, polyethylene wax, lubricating agent, colorant and blowing agent) is wt % based on polystyrene homopolymer weight.

5

#### Example 4 to 7 and Comparative Example C to G

The effect on Average Cell size and Extruder screw loading during forming a polymeric foam for many waxes are tested.

Prepare Ex 4-7 and Comp Ex C-G in like manner as Example 1 excepting include each cell size enlargement shown in Table 3 instead of Licowax PE520. The amount of each ingredients for each examples is also shown in Table 3. The properties of waxes are shown in Table 2.

5

Table 2

		Melting point (°C)	Average molecular weight (g/mol)	Other properties
Polyethylene wax	Hi WAX 220P	113	2,000	low density polyethylene
	Hi WAX 200P	130	2,000	High density polyethylene
	Licowax PE130	127-132	4,800	
	Licowax PE520	117-123	6,000	
	Licowax PE190	132-138	18,000	
Natural wax	Candelilla wax	68-72	-	
	Rice wax	78-82	-	
	Carnauba wax	80-86	-	

Hi WAX 220P and Hi WAX 200P are manufactured by Mitsui Chemical co. Ltd. Licowax PE130 and Licowax PE190 are manufactured by Clariant co. Ltd.

Extruder screw loading was determined by the following formula.

Extruder screw loading = (Actual throughput weight of foam per hour (kg/h)) / rotation  
10 frequency of extruder (rpm)

Actual throughput weight of foam per hour (kg/h) = (measured output weight of foam per hour (kg/h)) – (weight of injected foaming agent per hour (kg/h))



Table 3

		Ex 4	Ex 5	Ex 6	Ex 7	Comp Ex C	Comp Ex D	Comp Ex E	Comp Ex F	Comp Ex G
Flame retardant	Br-SBC	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Stabilizer	CN type epoxy resin	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
	Phosphate	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
	Epoxidized soybean oil	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Waxes	Hi wax 220P	0.3								
	Hi wax 200P		0.3							
	Licowax PE130			0.3						
	Licowax PE520				0.3					
	Licowax PE190					0.3				
	Candelilla wax						0.3			
	Rice wax							0.3		
	Carnauba wax								0.3	
Lubricating agent	Barium stearate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Colorant	Phthalocyanin e blue	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Blowing agent	Industrial butane	1.90	2.0	2.0	2.0	2.0	2.0	2.1	2.0	2.1
	Ethyl chloride	3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.0	4.1
	Carbonic dioxide	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.8	2.7
Extruder screw loading (kg/h· rpm)		0.26	0.26	0.28	0.23	0.17	0.15	0.14	0.15	0.22
Characteristi cs of foam	Density without skins (kg/m <sup>3</sup> )	48.6	43.8	40.4	40.3	41.7	37.3	28.1	29.2	40.8
	Average cell size diameter (millimeters)	0.94	0.89	0.73	0.66	0.57	0.53	0.50	0.54	0.20

In table 3, unit of each number for ingredients (flame retardant, stabilizer, waxes, lubricating agent, colorant and blowing agent) is wt % based on polystyrene homopolymer weight.

- 5 Many polyethylene waxes having an average molecular weight of 10,000 or less than 10,000 effectively counteracted the nucleating effect of Br-SBC (Ex 4-7) without affecting Extruder screw loading (compare Ex 4-7 to Comp Ex G). Cell size of the foam comprising polyethylene wax having 18,000 of Average molecular weight or natural wax is smaller than the one comprising polyethylene wax having 10,000 or less than 10,000, at the  
10 same time Extruder screw loading is lower. (compare Ex 4-7 to Comp Ex C-F)

#### Example 8 and Comparative Example H and I

The effect on Average Cell size for high pressure foam of JIS A9511 thermal insulation board class 3 is tested.

- 15 Prepare Ex 8 in like manner as Example 1 excepting using isobutene instead of Industrial butane. The amount of each ingredient is shown in Table 4.

Prepare Comp Ex H in like manner as Example 8 except do not include the polyethylene wax.

- 20 Prepare Comp Ex I in like manner as Example 8 except do not include either of the polyethylene wax and brominated styrene/butadiene/styrene block copolymer and instead includes HBCD as a flame retardant. As stabilizer, magnesium oxide is used instead of epoxy cresol novolac resin, phosphate and epoxidized soybean oil. The results are also shown in Table 4.

Table 4

		Ex 8	Comp Ex H	Comp Ex I
Flame retardant	Br-SBC	3.6	3.6	-
	HBCD	-	-	3.1
	Bromine content	2.3	2.3	2.3
Stabilizer	CN type epoxy resin	0.59	0.59	-
	Phosphate	0.35	0.35	-
	Epoxidized soybean oil	0.29	0.29	-
	Magnesium oxide	-	-	0.03
Polyethylene wax	Licowax PE520	0.05	-	-
Lubricating agent	Barium stearate	0.10	0.10	0.07
Colorant	Phthalocyanine blue	0.08	0.08	
Blowing agent	Iso butane	3.0	3.0	3.0
	Ethyl chloride	2.3	2.3	2.3
	Carbonic dioxide	1.7	1.7	1.7
Characteristics of foam	Density without skins (kg/m <sup>3</sup> )	46	42	44
	Average cell size diameter (millimeters)	0.33	0.13	0.26

In table 4, unit of each number for ingredients (flame retardant, stabilizer, polyethylene wax, lubricating agent, colorant and blowing agent) is wt % based on polystyrene homopolymer weight.

5

The foam characteristics reveal that Polyethylene wax effectively counteracted the nucleating effect of Br-SBC (compare Ex 8 to Comp Ex H) and to such an effect as to even produce a foam having a larger cell size than foam made using HBCD (compare Ex 8 to Comp Ex I).

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CLAIMS:

1. A polymer composition comprising: (1) a polymer component comprising styrenic polymer; (2) a brominated vinyl aromatic/butadiene copolymer; and (3) a polyethylene wax; wherein the concentration of the polyethylene wax is 0.02 to 1.0 weight percent based on weight of the polymer component, and the weight average molecular weight of the polyethylene wax is 10,000 g/mol or less and wherein the styrenic polymer is at least one polymer selected from the group consisting of homopolymer of styrenic monomer and copolymers containing copolymerized styrenic monomer and monomers including at least one monomer selected from the group consisting of methyl styrene, dimethyl styrene, ethyl styrene, diethyl styrene, isopropyl styrene, chloro styrene, dichloro styrene, trichloro styrene, vinyl toluene, vinyl xylene, divinyl benzene, acrylic acid, methacrylic acid, methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, acrylonitrile, maleic anhydride and itaconic anhydride.
2. The composition of Claim 1, wherein the weight average molecular weight of the polyethylene wax is 6,000 g/mol or less.
3. The composition of Claim 1 or 2, wherein the brominated vinyl aromatic/butadiene copolymer is a brominated styrene/butadiene/styrene triblock copolymer.
4. The composition of any one of Claims 1-3, wherein the styrenic polymer comprises polystyrene.
5. The composition of any one of Claims 1-4, wherein the polymer composition is an extruded polymeric foam.
6. The composition of any one of Claims 1-5, wherein the composition is in the form of a polymeric foam wherein the polymer component has cells defined therein.
7. A process for preparing the polymeric foam of Claim 5, the process comprising:
  - (a) melt blending the polymer component with the brominated vinyl aromatic/butadiene copolymer, polyethylene wax and a blowing agent to form a foamable polymer composition; and
  - (b) expanding the foamable polymer composition into a polymeric foam.