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(54) **Title:** FOAMABLE COMPOSITION AND FOAMED POLYMERS PREPARED THEREOF

(57) **Abstract:** The present invention relates to a foamable composition for the preparation of foamed polymers. The invention further relates to foamed polymers prepared from the foamable composition and to a process for preparing the foamed polymers.



Foamable composition and Foamed polymers prepared thereof

This application claims priority to European application No. EP 12177207.3 filed on July 20, 2012, the whole content of this application being incorporated herein by reference for all purposes.

5 The present invention relates to a foamable composition for the preparation of foamed polymers. The invention further relates to foamed polymers prepared from the foamable composition and to a process for preparing the foamed polymers.

10 Foamed polymers are commonly used for a wide variety of applications and are well-known to a person skilled in the art. Foamed polymers are materials that have cells, which are filled with a gas and distributed throughout the entire mass of the foamed polymer. Such cells are small cavities formed during the manufacture of the foamed polymer; these cavities are enclosed partly or completely by cell walls. In contrast to an open cell, a closed cell is completely
15 surrounded by its walls and, therefore, is not interconnected with other cells.

 Foamed polymers are commonly produced by using physical blowing agents such as compressed gases or low boiling hydrocarbons or halogenated hydrocarbons or, alternatively, by using chemical blowing agents. Chemical blowing agents are typically solids which decompose at elevated temperatures,
20 wherein a gas is formed. In the past, inorganic blowing agents such as ammonium hydrogen carbonate were commonly used for the manufacturing of foamed polymers. However, today mainly organic blowing agents are used for this purpose. Most commonly used chemical blowing agents are *p*-toluenesulfonhydrazide, 4,4'-oxybis(benzenesulfonhydrazide), N,N'-
25 dinitrosopentamethylenetetramine, and azodicarbonamide. Despite their higher price, organic blowing agents provide a number of advantages over previously used inorganic blowing agents such as ammonium hydrogencarbonate. Organic blowing agents can be usually better dispersed in the polymer formulation, provide higher gas yields, decompose within a narrower temperature range and
30 are sufficiently stable upon storage. However, the use of organic blowing agents is compromised by several disadvantages, such as an unpleasant fishy odor which results from traces of amines present in the foamed polymer and residues of toxicologically harmful compounds, such as formaldehyde and N-

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nitrosamines. Moreover, many commonly-used organic blowing agents are known to be explosive and, therefore, their use is limited for safety reasons.

GB 632,208 reports that hydrogen peroxide and organic peroxides, such as urea peroxide, acetyl peroxide, benzoyl peroxide and the like can be advantageously employed as blowing agents for the preparation of foamed polymers. The oxygen release from the hydrogen peroxide is initiated upon addition of an excess of potassium permanganate solution to the foamable composition. Accordingly, a large amount of potassium permanganate is required for the process of GB 632,208.

US 3,352,803 discloses a method for the preparation of foamed polyurethane elastomers. This method comprises reacting a polyurethane prepolymer having terminal isocyanato groups, being the reaction product of a polyether and dicyclohexylmethane diisocyanate or hexamethylene diisocyanate, with hydrogen peroxide, water and a catalyst to thereby expand the pre-polymer into a foamed condition and to simultaneously effect cross-linking of the foamed polymer. As catalysts, dialkyl tin diesters such as, for instance, dibutyl tin dilaurate are employed. One of the main disadvantages of this method results from toxicity of tin compounds which remain incorporated into the resulting foamed polymer and present a significant health hazard to the customer.

US 3,709,725 relates to a process for producing textile goods which are coated with foamed polyvinyl chloride. This process employs hydrogen peroxide in combination with compounds such as $\text{Pb}_3(\text{PO}_3)_2$, FeSO_4 , NaHSO_3 , Na_2SO_3 or CuCl . US 3,709,725 teaches *inter alia* that use of 0.5% lead phosphite provides a good coating on the textile goods. However, use of such textile goods is significantly restricted because of toxicity of compounds of lead, iron and copper which remain incorporated therein.

US 6,140,380 discloses blowing agents comprising at least one metal silicate, boric acid or a salt thereof, a peroxy compound, a reaction initiator, water and optionally a desiccant. The method for producing foamed polymers of US 6,140,380 can employ hydrogen peroxide as a peroxy compound and a broad range of thermoset and thermoplastic polymers. However, also this method for producing foamed polymers requires that toxic compounds such as boric acid or salts thereof are used.

Thus, there is still a demand for an environmentally friendly and simple process for the preparation of foamed polymers. Such process should preferably employ only non-toxic materials and the foamed polymers produced by this

process should not contain any toxic residues or residues with an unpleasant odor.

The authors of the present invention surprisingly found that an alkaline earth metal oxide in combination with hydrogen peroxide can be advantageously used as a blowing agent for the preparation of a foamed polymer. In this case no additional catalytic agent, such as boric acid or salts thereof is required.

Accordingly, the first aspect of the present invention relates to a foamable composition comprising

- a) a polymer;
- b) hydrogen peroxide or a hydrogen peroxide source; and
- c) an activating agent,

characterized in that the activating agent is an alkaline earth metal oxide and the foamable composition comprises no boric acid or salts thereof.

Thus, the foamable composition of this aspect of the present invention contains no boric acid or salts thereof and preferably no compounds of transition metals. In a particularly preferred embodiment, the foamable composition of the present invention further contains no silicates. Therefore, the preparation process of the present invention can be considered to be environmentally friendly and the resulting foamed polymer is non-toxic and safe for use in a broad variety of applications.

Furthermore, the authors of the present invention surprisingly found that a combination of hydrogen peroxide and a manganese(II) compound can also be advantageously used as a chemical blowing agent. Accordingly, the second aspect of the present invention relates to a foamable composition comprising

- a) a polymer;
- b) hydrogen peroxide or a hydrogen peroxide source; and
- c) a catalytic agent,

characterized in that the catalytic agent is a manganese(II) compound.

Another aspect of the present invention relates to the preparation of foamed polymers having a low density, for example equal to or below about 200 g/l, such as between about 100 g/l and about 200 g/l. Such foamed polymers can be advantageously employed in a wide variety of applications. For instance, flexible polyvinyl chloride foams having a low density are commonly employed for flooring applications, for the production of wallpaper and as artificial leather. Consequently, a further technical problem to be solved by the present invention is to provide a foamed polymer having a low density. Preferably, this foamed

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polymer should not contain any compounds which are toxic or have a strong and/or unpleasant odor.

This problem has been solved by the third aspect of the present invention. Accordingly, the third aspect of the present invention relates to a foamable

5 composition comprising

- a) a polymer;
- b) hydrogen peroxide or a hydrogen peroxide source;
- c) a catalytic agent; and
- d) an activating agent,

10 characterized in that the catalytic agent is a compound of a transition metal selected from the 3rd to the 11th group of the periodic table and the activating agent is an alkaline earth metal oxide.

The foamable composition of the above first aspect of the invention may additionally contain a catalytic agent as described below. The foamable
15 composition of the above second aspect of the invention may additionally contain an activating agent as described below.

The hydrogen peroxide for use in the present invention can be from any suitable source, such as in form of a hydrogen peroxide solution, hydrogen peroxide in gel form or a solid source of hydrogen peroxide, such as a solid
20 percarbonate powder, in particular sodium percarbonate. The choice of the aqueous hydrogen peroxide source for use in the present invention is not particularly limited and for example any aqueous hydrogen peroxide solution can be employed. An aqueous hydrogen peroxide solution of technical grade is suitable. Preferably, the aqueous hydrogen peroxide solution contains between
25 about 10 wt.-% and about 50 wt.-% of hydrogen peroxide, more preferred between about 20 wt.-% and about 40 wt.-% of hydrogen peroxide, based on the total weight of the hydrogen peroxide solution.

The amount of the hydrogen peroxide (as 100%) in the foamable composition depends on the level of foaming necessary for the specific
30 application and typically ranges between about 0.1 wt.-% and about 10 wt.-% based on 100 parts of polymer in the foamable composition, preferably between about 1.0 wt.-% and about 8.0 wt.-%, based on 100 parts of polymer in the foamable composition. If the polymer is in the form of a plastisol as described below, these amounts are based on 100 parts of plastisol in the foamable
35 composition.

The gas released by the foamable composition of the present invention mainly consists of molecular oxygen. However, in some particular embodiments of the present invention, for instance when the polymer is a polyurethane, the gas released by the foamable composition further may contain carbon dioxide or other gases.

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In one preferred embodiment of the present invention, the polymer is in the form of a plastisol. The term "plastisol" relates to a suspension of polymer particles in a liquid plasticiser. Preferably, plastisol is a suspension of polyvinyl chloride particles in a liquid plasticiser. The choice of the plasticiser is not particularly limited and, therefore, commonly employed plasticisers, such as dioctylphtalate or 1,2-cyclohexyldicarboxylic acid diisononyl ester can be used for this purpose.

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The terms "polyvinyl chloride" intend to designate vinyl chloride homopolymers as well as copolymers of vinyl chloride with other ethylenically unsaturated monomers which are either halogenated (chloroolefins like vinylidene chloride; chloroacrylates; chlorinated vinylethers) or non halogenated (olefins like ethylene and propylene; styrene; vinylethers like vinyl acetate) monomers; as well as vinyl chloride copolymers with acrylic and methacrylic acids; esters, nitriles and amides. Vinyl chloride homopolymers and vinyl chloride copolymers containing 50-99 weight %, preferably 60-85 weight % of vinyl chloride are preferred.

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The amount of the plastisol in the foamable composition typically ranges between about 20 wt.-% and about 90 wt.-% based on the total weight of the foamable composition. The amount of plastisol can be selected according to the desired final characteristic of the foamable composition.

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In another preferred embodiment of the present invention, the polymer is in the form of a hydrosol. The term "hydrosol" as used herein relates to a colloidal system in which the polymer particles are dispersed in water. Preferably, the hydrosols further contain at least one surfactant and at least one plasticizer. Preferably, the hydrosol employed in the present invention is a dispersion of polyvinyl chloride and a plasticizer in water, which can optionally contain other components.

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The polymer employed in the process of the present invention is not particularly limited and any suitable thermoplastic and thermoset polymers can be used. Suitable thermoplastic polymers for use in the present invention include but are not limited to polyolefins, such as polyethylene, polypropylene,

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polystyrene, polyvinyl chloride, polytetrafluoroethylene, polyvinyl acetate as well as mixtures and co-polymers thereof. In yet another preferred embodiment, the suitable thermoplastic polymer is selected from polyesters such as polyethylene terephthalate, polyethylene adipate or polyethylene succinate or
5 from the group of polyamides such as poly-4-aminobutyric acid, poly-6-aminohexanoic acid, poly-7-aminoheptanoic acid, poly-8-aminooctanoic acid, polyhexamethylene adipamide or polydecamethylene sebacamide. Alternatively, the thermoplastic polymer may be selected from the group of polycarbonates, such as polymethane bis-4-phenyl carbonate, poly-2,2-propane bis-4-phenyl
10 carbonate and the like. The suitable thermoplastic polymer may also be selected from the group consisting of polymethacrylic acid esters, polyacrylic acid esters, polyacrylonitrile and the like.

Examples of thermoset polymers for use in the present invention include, but are not limited to urethanes, isocyanurates, phenolics, silicones and urea
15 formaldehydes.

The term "transition metal" as used herein, relates to elements of the 3rd to the 11th group in the periodic system. Transition metals according to the present invention include but are not limited to scandium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel and copper. Preferably, transition
20 metals according to the present invention are manganese, iron, cobalt, nickel or copper, wherein manganese is particularly preferred.

Most preferably, the catalytic agent is a manganese(II) compound. Mn compounds have the advantage of being cheap and readily available, and of impairing little coloration after reaction with H₂O₂.

The choice of the manganese(II) compound is not particularly limited and any manganese(II) compound can be employed. Thus, the manganese(II) compound can be manganese(II) chloride, manganese(II) bromide, manganese(II) sulphate, manganese(II) nitrate or manganese(II) acetate. Preferably, the catalytic agent is selected from the group consisting of
30 manganese(II) chloride, manganese(II) bromide and manganese(II) sulphate, wherein manganese(II) sulphate is particularly preferred. The catalytic agent may be in the anhydrous form, in the form of a hydrate or in the form of an aqueous solution.

Preferably, the amount of the catalytic agent (Mn or other metal as 100%)
35 used in the foamable composition of the present invention is equal to or less than about 1 wt.-%, based on the weight of the polymer or (if present) plastisol in the

foamable composition. It is further preferred that the amount of the catalytic agent used in the foamable composition of the present invention is equal to or more than about 0.001 wt.-%, more preferred equal to or more than about 0.002 wt.-%, , based on the weight of the polymer or (if present) plastisol in the foamable composition. Accordingly, the amount of the catalytic agent used in the foamable composition of the present invention preferably ranges between about 0.001 wt.-% and about 1 wt.-%, based on the weight of the polymer or (if present) plastisol in the foamable composition.

According to the present invention, the activating agent is an alkaline earth metal oxide. The alkaline earth metal oxide is selected from the group consisting of magnesium oxide, calcium oxide, strontium oxide and barium oxide. Preferably, the activating agent is selected from the group consisting of magnesium oxide and calcium oxide. In a particularly preferred embodiment, the activating agent is calcium oxide.

Preferably, the amount of the activating agent used in the foamable composition of the present invention is equal to or less than about 8 wt.-%, more preferred equal to or less than about 6 wt.-%, based on the weight of the polymer or (if present) plastisol in the foamable composition. It is further preferred that the amount of the activating agent used in the foamable composition of the present invention is equal to or more than about 0.01 wt.-%, more preferred equal to or more than about 0.2 wt.-%, based on the weight of the polymer or (if present) plastisol in the foamable composition. Accordingly, the amount of the activating agent used in the foamable composition of the present invention preferably ranges between about 0.01 wt.-% and about 8 wt.-%, more preferred between about 0.05 wt.-% and about 6 wt.-%, , based on the weight of the polymer or (if present) plastisol in the foamable composition.

The composition of the present invention may further comprise an organic solvent. The choice of the organic solvent is not particularly limited. In one embodiment of the present invention, the organic solvent is an organic carbonate solvent, for instance, ethylene carbonate, propylene carbonate, butylene carbonate, glycerine carbonate or a mixture thereof.

In yet another embodiment of the present invention, the organic solvent may be a trialkyl phosphate, such as tris(2-chloro-1-propyl) phosphate or trioctyl phosphate.

In a further embodiment of the present invention, the organic solvent may be a mixture of hydrocarbons, preferably a mixture of aliphatic hydrocarbons,

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more preferred a mixture of aliphatic hydrocarbons having an initial boiling point of not less than about 220°C and the dry point of not more than about 280°C, for instance, the initial boiling point of not less than about 234°C and the dry point of not more than about 267°C. Corresponding organic solvents are for example commercially available under the trademark Exxsol™, for instance, as products Exxsol™ D100 and Exxsol™ D110 from ExxonMobil Chemical (ExxonMobil Chemical, Houston, USA).

The initial boiling point and the dry point of organic solvents can be determined by ASTM D 1078-05. Distillation ranges of petroleum products can be further determined by ASTM D 86 11a. All measurement are carried out at atmospheric pressure of 101 kPa.

The amount of the solvent in the foamable composition is preferably between about 1 wt.-% and about 50 wt.-%, based on the weight of the polymer or (if present) plastisol in the foamable composition.

In one embodiment of the present invention, the foamable composition further comprises a surfactant. The surfactant which may be used for this purpose may be a non-ionic, an anionic or a cationic surfactant. Non-ionic surfactants are commercially available and well-known to a person skilled in the art. For instance, such surfactants are available under the trademark Triton X™ surfactants from Dow Chemical (The Dow Chemical Company, Texas, USA). Thus, suitable surfactants for use in the foamable composition of the present invention include, but are not limited to non-ionic surfactants, such as Triton X-100 octylphenol etoxilates, Triton X-102, Triton X-114, Triton X-165, Triton X-301 polyether sulphate and Triton X-305, wherein Triton X-100 is particularly preferred.

Other surfactants from Dow Chemical are those available under the trademark Tergitol™, namely secondary alcohol etoxilates like Tergitol TMN - Tergitol 15S, or nonyl phenol etoxilates like Tergitol NP. Organomodified siloxane surfactants acting as wetting and dispersing agents like the product available under the trademark Tegopren® 5885 from Evonik, can also be used.

Preferably, the amount of the surfactant used in the foamable composition of the present invention is equal to or less than about 8 wt.-%, more preferred equal to or less than about 6 wt.-%, based on the weight of the polymer or (if present) plastisol in the foamable composition. It is further preferred that the amount of the surfactant used in the foamable composition of the present invention is equal to or more than about 0.01 wt.-%, more preferred equal to or

more than about 0.05 wt.-%, based on the weight of the polymer or (if present) plastisol in the foamable composition. Accordingly, the amount of the surfactant used in the foamable composition of the present invention preferably ranges between about 0.01 wt.-% and about 8 wt.-%, more preferred between about 0.05 wt.-% and about 6 wt.-%, based on the weight of the polymer or (if present) plastisol in the foamable composition.

The foamable composition of the present invention may contain further components, for instance, foam stabilizers; fillers or extenders, such as carbon black; other polymers and oils; curing agents, such as sulfur compounds and various chemicals that act as a part of a curing system, such as zinc oxide; antistatic agents; biocides; colorants; coupling agents; fibrous reinforcements; flame retardants; fungicides; heat stabilizers; lubricants; mold release agents; plasticizers; preservatives; processing aids; slip agents; ultraviolet stabilizers; viscosity depressants; and any other ingredient that may be a desirable component of the resulting foamed polymer.

Another aspect of the present invention relates to a process for preparing the foamable composition as described above, wherein the process comprises the following steps:

- a) premixing of the polymer, wherein, optionally, the solvent and, optionally, the surfactant are added thereto;
- b) optionally, addition of the catalytic agent to the mixture obtained in step a);
- c) addition of hydrogen peroxide or a hydrogen peroxide source; and
- d) optionally, addition of the activating agent.

The process can be carried out in conventional equipment, for example made of Austenitic Stainless Steel (304L-316L etc). The process can also be carried out in non-metallic materials like, plastics, glass and ceramics for chemical use.

Preferably, the steps a) to d) of the process are carried out under continuous mixing. Because the foamable composition of the present invention has a relatively high viscosity, a powerful mixing is required for obtaining a homogeneous foamable composition. Moreover, because the blowing effect already starts taking place during the mixing, the speed of mixing should be sufficiently high in order to achieve a good homogenisation within a short period of time. Preferably, the homogenisation is achieved within less than about 20 seconds during each step of the process. The selection of the mixing conditions depends upon the specific characteristics of the equipment.

The above steps a) to d) of the process for preparing the foamable composition of the present invention can be carried out at any suitable temperature as in conventional foam production, the process can for example be carried out at relatively low temperatures (ambient) ranging between about 0°C and about 30°C, for instance at about 20°C. For example by using a reticulating agent the foam can set at ambient condition.

A further aspect of the present invention relates to a process for preparing a foamed polymer, wherein the above described foamable composition is optionally heated. Thereby, the foamable composition can be prepared according to the above steps a) to d).

Thus, the process for preparing a foamed polymer can comprise the following steps:

- a) premixing of the polymer, wherein, optionally, the solvent and, optionally, the surfactant are added thereto;
- b) optionally, addition of the catalytic agent to the mixture obtained in step a);
- c) addition of hydrogen peroxide or a hydrogen peroxide source;
- d) optionally, addition of the activating agent; and
- e) heating of the mixture obtained in step d).

Preferably, the step e) is carried out immediately after the completion of the step d).

The heating in step e) can be carried out at a temperature between about 120°C and about 200°C, depending on the resin and the composition of plastisol. This range of temperatures is lower than the temperatures usually employed during preparation of foamed polymers of the prior art, thereby saving energy, time and costs.. Accordingly, the present invention provides a more energy-efficient process than the comparable prior art processes.

Preferably, the polymer, for instance polyvinyl chloride melts during the step e) and modifies the viscosity of the mixture to a level at which the gas is substantially retained in it. Thus, a foamed polymer with small and evenly dispersed cavities and having the desired properties and shape is formed.

The time of heating in step e) depends on the formulation of plastisol, shape of the material, temperature and the like.

A further aspect of the present invention relates to a foamed polymer, wherein the foamed polymer is obtainable from the foamable composition as described above.

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In one embodiment of the invention, the foamed polymer is a flexible foamed polymer. In this embodiment, the foamed polymer is preferably flexible polyvinyl chloride and can be advantageously used

- for flooring applications;
- 5 • for production of wall paper foam based;
- as artificial leather; or
- as technical foam.

Moreover, the flexible foamed polyvinyl chloride of the present invention is a robust non-flammable material which therefore can also be used for
10 construction application such as:

- thermal isolation in walls;
- acoustic isolation in walls;
- piping coating;
- windows insulation;
- 15 • packaging; or
- shock absorber.

In yet another embodiment, the foamed polymer of the present invention is rigid, for instance a rigid polyvinyl chloride foam. Because the gas is well dispersed in the mass of the polyvinyl chloride material prior/during the step e),
20 the gas is substantially retained creating small and well dispersed cavities. This leads to superior insulating properties of the resulting foamed polyvinyl chloride.

A person skilled in the art will readily appreciate that if the foamable composition of the present invention contains an alkaline earth metal oxide, the foamed polymer obtainable from this foamable composition will contain at least
25 one compound of this alkaline earth metal. Accordingly, if the foamable composition of the present invention contains a compound of a transition metal selected from the 3rd to the 11th group of the periodic table, the foamed polymer obtainable from this foamable composition will contain at least one compound of this transition metal.

30 Yet another aspect of the present invention relates to use of calcium oxide as an activating agent for the preparation of a foamed polymer. Finally, a further aspect of the present invention relates to use of manganese(II) sulfate as a catalytic agent for the preparation of a foamed polymer.

Examples

35 The following non-limiting examples will illustrate some representative embodiments of the invention in detail.

The examples were carried out at ambient temperature of 25°C and at atmospheric pressure of 101 kPa unless specified otherwise. The samples of plastisol were freshly prepared, and characterised by measuring their viscosity. Thus, all tests employed the same plastisol as raw material.

5 **Example 1**

The materials used for the experiments are listed in Table 1 below. The laboratory type mixer type Dispermat CV was used that allows mixing at 4000 rpm. That stirring speed was used for two reasons:

1. The viscosity of the product needs a powerful mixing to achieve a homogeneous final product.
2. A powerful mixing allows reaching a quick homogeneous dispersion of the peroxide within only 5 seconds. This is desirable taking into account that the decomposition of hydrogen peroxide is already happening during the mixing. Therefore, an insufficiently fast mixing would lead to a loss of expansion of the foamed polymer.

Components	Description	Remarks
Plastisol	100 PCR 367NF, 40PCR DINP, 2PCR MOK17	367NF is the PVC resin 100 parts + DINP is the plasticizer 40 parts on 100 parts of resin (40PCR), MOK 17 is a thermal stabilizer 2 part on 100 part of resin (2 PCR)
Aqueous MnSO ₄ solution	Solution at 1.137 g/l as Mn ²⁺	Freshly prepared from MnSO ₄
Aqueous H ₂ O ₂ solution	30 wt.-%	Obtained by dilution of 50 wt.-% H ₂ O ₂
Jeffsol BC	Butylene carbonate	As received
CaO	Sigma Aldrich	Reagent grade
Triton X-100	Dow Chemical	As received

Table 1

The laboratory process was performed in four steps. The mixing was never stopped till the addition of the last component.

- a) First, a premix at high speed (4000 rpm) was performed with: Plastisol, Jeffsol BC and Triton X-100;
- b) then the catalytic agent (aqueous MnSO₄ solution) was added;
- c) then hydrogen peroxide was added;
- d) then the activating agent (CaO) was added.

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After the addition of the last component, the obtained mixture was quickly poured in the mold and placed in the oven for 10 to 15 minutes at 160 – 180°C.

Finally, the volumes of the foamed polymer samples were determined. The obtained experimental results are summarized in Table 2.

Test	Components						Volume, ml
	Plastisol, g	Jeffsol, g	MnSO ₄ , ml	H ₂ O ₂ , ml	CaO, g	Triton X- 100, g	
1	40.7	10	1	4	0.3	0.5	190
2	40.7	10	1	5	0.3	0.5	280
3	40.7	10	1	5	0.3	0.5	240
4	40.7	10	1	6	0.3	0.5	290
5	40.7	10	1	7	0.3	0.5	310

5 Table 2

Example 2

Test 4 of example 1 was repeated twice (tests 6 and 7), and then further tests were carried out without the catalytic agent MnSO₄ (tests 8 and 9) and without the activating agent CaO (tests 10 and 11). Aqueous 29.8 wt.-%
10 hydrogen peroxide and MnSO₄ having 1.137 g/l were used for the tests 6-11.

After the obtained samples of foamed polymer were cooled to ambient temperature, their density was determined.

The amount of components employed in the tests and densities of the obtained foamed polymer samples are summarized in Table 3.

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Test	Components						Density, g/l	
	Plastisol, g	Jeffsol, g	MnSO ₄ , ml	H ₂ O ₂ , ml	CaO, g	Triton X-100, g	Evaluated	Average measured by immersion
6	40.7	10	1	6	0.3	0.5	128	120
7	40.7	10	1	6	0.3	0.5	122	
8	40.7	10	0	6	0.3	0.5	880	720
9	40.7	10	0	6	0.3	0.5	858	
10	40.7	10	1	6	0	0.5	1169	890
11	70	17.2	1.72	10.32	0	0.86	1006	

Table 3

The formulation comprising MnSO₄ and CaO gave a foamed polymer having an average density of 120 g/l (tests 6 and 7) while the formulation comprising CaO but no MnSO₄ (test 8 and 9) yielded a foamed polymer having an average density of 720 g/l. The formulation comprising the catalytic agent but no CaO yielded a foamed polymer having an average density of 890 g/l (tests 10 and 11).

Should the disclosure of any patents, patent applications, and publications which are incorporated herein by reference conflict with the description of the present application to the extent that it may render a term unclear, the present description shall take precedence.

C L A I M S

1. A foamable composition comprising:

- a) a polyvinyl chloride plastisol;
- b) hydrogen peroxide or a hydrogen peroxide source;
- 5 c) a catalytic agent; and
- d) an activating agent,

characterized in that

the catalytic agent is a compound of a transition metal selected from the 3rd to the 11th group of the periodic table and the activating agent is an alkaline earth
10 metal oxide.

2. The foamable composition according to claim 1, wherein the hydrogen peroxide or hydrogen peroxide source is in the form of an aqueous solution, a hydrogen peroxide gel or a solid percarbonate powder, preferably in the form of an aqueous solution comprising between about 10 wt.-% and about 50 wt.-% of
15 hydrogen peroxide.

3. The foamable composition according to any of claims 1 or 2, wherein the catalytic agent is a manganese compound.

4. The foamable composition according to any of claims 1 to 3, wherein the catalytic agent is manganese(II) sulfate and/or the activating agent is calcium
20 oxide.

5. The foamable composition according to any of claims 1 to 4, further comprising an organic solvent and/or a surfactant.

6. A process for preparing a foamable composition according to any of claims 1 to 5, comprising the following steps:

- 25 a) premixing of the polyvinyl chloride plastisol, wherein, optionally, the solvent and, optionally, the surfactant are added thereto;

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- b) addition of the catalytic agent to the mixture obtained in step a);
- c) addition of hydrogen peroxide or a hydrogen peroxide source;
- d) addition of the activating agent.

5 7. A process for preparing a foamed polymer, wherein the foamable composition according to any of claims 1 to 5 is heated, the heating being preferably carried out at a temperature between about 140°C and about 200°C.