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3,782,941  
**PHOTOTHERMOGRAPHIC ELEMENT,  
COMPOSITION AND PROCESS**  
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U.S. Cl. 96—48 HD **18 Claims**

## ABSTRACT OF THE DISCLOSURE

An N-hydroxynaphthalimide accelerator-toning agent in photothermographic elements, compositions and processes provides improved results in shorter processing time and at lower concentrations. The N-hydroxynaphthalimide compounds can be employed in photothermographic materials and/or thermographic materials in combination with reducing agents. Other addenda commonly employed in photothermographic materials such as sensitizing dyes, image stabilizers and stabilizer precursors and various photosensitive compounds can be employed in the photothermographic materials also.

## BACKGROUND OF THE INVENTION

### Field of the invention

This invention relates to certain accelerator-toning agents in photothermographic and/or thermographic elements, compositions and processes to provide improved results in shorter processing time and at lower concentrations. In one of its aspects it relates to photothermographic elements containing such accelerator-toning agents with an oxidation-reduction image forming combination comprising a heavy metal salt oxidizing agent with a reducing agent. In another of its aspects it relates to a photothermographic composition containing the described accelerator-toning agents. A further aspect relates to a method of developing a latent image in the described photothermographic elements by overall heating the exposed element.

### Description of the state of the art

It is well known in the art to provide photothermographic materials containing so-called accelerator-toning agents. Such photothermographic materials after exposure are overall heated to provide a developed image in the absence of processing solutions. Accelerator-toning agents which have been employed in photothermographic materials are described, for example, in U.S. Pat. 3,457,075 of Morgan et al., issued July 22, 1969; U.S. Pat. 3,152,904 of Sorenson et al., issued Oct. 13, 1964; U.S. Pat. 3,152,903 of Sorenson et al., issued Oct. 13, 1964; British specification No. 1,161,777 published Aug. 20, 1969; Belgian Pat. 766,590 published June 15, 1971, and Belgian Pat. 766,589 published June 15, 1971. Various photothermographic materials in which the described accelerator-toning agents can be employed include those described in Belgian Pat. 765,452 published May 28, 1971; Belgian Pat. 765,602 published May 28, 1971; Belgian Pat. 765,601 issued May 28, 1971, and Belgian Pat. 772,371 published Oct. 15, 1971. An accelerator-toning agent which has been found useful in photothermographic materials is phthalimide, also known as an activator-toning agent. This is described in Belgian Pat. 766,590 published June 15, 1971.

There has been a continuing need to provide improved results in shorter processing time and at lower concentrations of so-called activator-toning agents in photothermographic elements, compositions and processes.

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## SUMMARY OF THE INVENTION

It has been found according to the invention that improved results in shorter processing time and at lower concentrations of so-called activator-toning agent upon processing with heat is provided in a photothermographic element and/or composition comprising a photosensitive component, an oxidation-reduction image forming combination comprising a heavy metal oxidizing agent with a reducing agent and an imide activator-toning agent with a binder, by employing an N-hydroxynaphthalimide activator-toning agent, especially an N-hydroxy-1,8-naphthalimide activator-toning agent, in the photothermographic element and/or composition. The N-hydroxynaphthalimide activator-toning agent can provide synergistic results when used in combination with other toner-accelerators, also known as activator-toning agents and/or accelerator-toning agents, such as phthalimide.

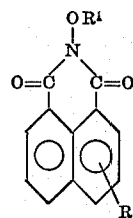
The described image-forming combination is used with a photosensitive component which is believed to be a catalyst for the oxidation-reduction combination, preferably photosensitive silver halide. The N-hydroxynaphthalimide activator-toning agents, also known as accelerator-toning agents and/or toner-accelerators, are especially useful with certain reducing agents in the oxidation-reduction image forming combination such as sulfonamido-phenol reducing agents.

The described N-hydroxynaphthalimide activator-toning agents are also useful in thermographic materials.

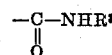
## DETAILED DESCRIPTION OF THE INVENTION

Various N-hydroxynaphthalimide accelerator-toning agents are useful in photothermographic elements and compositions according to the invention. One test which can be used in determination of suitable N-hydroxynaphthalimide accelerator-toning agents is set out in following Example 1. Choice of an optimum N-hydroxynaphthalimide accelerator-toning agent will depend upon the particular photothermographic element, composition, desired image, processing conditions and the like. The N-hydroxynaphthalimide accelerator-toning agents useful according to the invention can be prepared employing known procedures in the art.

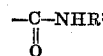
A useful class of N-hydroxynaphthalimide accelerator-toning agents according to the invention is represented by the formula:



wherein R<sup>1</sup> is hydrogen or



wherein R<sup>3</sup> is alkyl containing 1 to 4 carbon atoms, such as methyl, ethyl, propyl or butyl, or phenyl; R<sup>2</sup> is hydrogen, alkyl containing 1 to 4 carbon atoms, such as methyl, ethyl, propyl or butyl, hydroxy, methoxy, chlorine, bromine or iodine. N-hydroxynaphthalimide, as employed herein, is intended to include those compounds containing the structure



as described. It is believed that this group upon overall heating acts as a precursor to a naphthalimide compound which provides acceleration and toning activity. The de-

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scribed alkyl group includes such groups containing substituents which do not adversely affect the accelerator-toning properties and desired sensitometric properties of the described photothermographic elements and compositions. Examples of substituent groups which can be present are methyl, ethyl or propyl groups. It is desirable to avoid strong electron withdrawing groups on the phthalimide nucleus such as nitro groups, cyano and sulfonic acid groups. These adversely affect the desired properties of the compound in most instances.

Examples of suitable N-hydroxynaphthalimide accelerator toning agents include: N-hydroxy-1,8-naphthalimide; 4-bromo-N-hydroxy-1,8-naphthalimide; 3-hydroxy-N-hydroxy-1,8-naphthalimide; and 3-methoxy-N-hydroxy-1,8-naphthalimide.

Combinations of N-hydroxynaphthalimide accelerator-toning agents, as described, can be employed in photothermographic materials and elements according to the invention.

One embodiment of the invention is in photothermographic element comprising a support having thereon a photosensitive component, an oxidation-reduction image forming combination comprising a heavy metal salt oxidizing agent with a reducing agent and an imide accelerator toner, also known as an activator-toning agent, and a binder, the improvement wherein said imide activator-toner comprises an N-hydroxynaphthalimide activator-toning agent, as described.

The described photothermographic element comprises a photosensitive component, which is typically a photosensitive salt, such as a photosensitive silver salt. It is believed that the photosensitive salt acts as a catalyst for the described oxidation-reduction image forming combination. A typical concentration range of photosensitive component, especially photosensitive silver salt, is from about 0.01 to about 20.0 moles of photosensitive component per mole of heavy metal salt oxidizing agent, for example, per mole of silver salt of organic acid. An especially useful photosensitive component is a photosensitive silver halide. Useful photosensitive silver salts, however, include silver dye complexes and combinations of photosensitive silver halide with other silver photosensitive salts. Preferred photosensitive silver halides are silver chloride, silver bromide, silver bromoiodide, silver chlorobromoiodide or mixtures thereof. The photosensitive silver halide can be coarse or fine grain, very fine grain photosensitive silver halide being especially useful. The photosensitive silver halide can be prepared by any of the procedures known in the photographic art. Such procedures and forms of photosensitive silver halide are described, for example, in the Product Licensing Index, vol. 92, December 1971, publication 9232, pp. 107-110, para. I. The photosensitive silver halide employed according to the invention can be unwashed, or washed, can be chemically sensitized, can be protected against the production of fog and/or stabilized against loss of sensitivity during keeping, as described in the above Product Licensing Index reference.

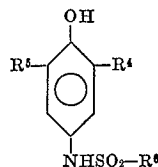
The photothermographic elements and/or compositions according to the invention comprise an oxidation-reduction image forming combination which contains an oxidizing agent, preferably a heavy metal salt oxidizing agent. The heavy metal salt oxidizing agent can be a heavy metal salt of an organic acid such as a fatty acid which is resistant of darkening upon illumination. An especially useful class of heavy metal salts of organic acids is represented by the water insoluble silver salts of long-chain fatty acids which are stable to light. Compounds which are suitable silver salt oxidizing agents include silver behenate, silver stearate, silver oleate, silver laurate, silver hydroxystearate, silver caprate, silver myristate and silver palmitate. Silver salts can be employed as the heavy metal salt oxidizing agent which are not silver salts of long-chain fatty acids. Such silver salt oxidizing agents which are useful include, for example, silver benzoate, silver

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benzotriazole, silver terephthalate, silver phthalate and the like. In most cases, the preferred heavy metal salt oxidizing agent is a silver salt of a long-chain fatty acid such as silver stearate and/or silver benenate.

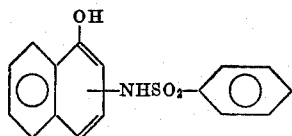
The described N-hydroxynaphthalimide accelerator-toning agents can be employed in combination with various reducing agents in the described oxidation-reduction image forming combination. Suitable reducing agents which can be employed in combination with the N-hydroxynaphthalimides as described include substituted phenols and naphthols, for example bis-beta-naphthols. Suitable bis-beta-naphthols include, for example, 2,2'-dihydroxy-1,1'-binaphthyl, 6,6'-dibromo-2,2'-dihydroxy-1,1'-binaphthyl, 6,6'-dinitro-2,2'-dihydroxy-1,1'-binaphthyl and/or bis-(2-hydroxy-1-naphthol)methane. Other reducing agents which can be employed in photothermographic elements, according to the invention, include polyhydroxybenzenes such as hydroquinone, alkyl-substituted hydroquinones such as tertiary butyl hydroquinone, methyl hydroquinone, 2,5-dimethyl hydroquinone and 2,6-dimethyl hydroquinone; catechols, and pyrogallols, chloro-substituted hydroquinones such as chloro hydroquinone or dichloro hydroquinone; alkoxy-substituted hydroquinone such as methoxy hydroquinone or ethoxy hydroquinone; aminophenol developing agents, such as 2,4-diaminophenols and methylaminophenols; ascorbic acid developing agents such as ascorbic acid, ascorbic acid ketals and ascorbic acid derivatives; hydroxylamine developing agents; 3-pyrazolidone developing agents such as 1-phenyl-3-pyrazolidone and 4-methyl-4-hydroxymethyl-1-phenyl-3-pyrazolidone and the like. Combinations of reducing agents can be employed if desired.

Especially useful reducing agents which can be employed in combination with the described N-hydroxynaphthalimide accelerator-toning agents are sulfonamidophenol reducing agents as described in copending application Ser. No. 272,832 of Evans and McLean, filed concurrently herewith. Sulfonamidophenol reducing agents in the described photothermographic materials also provide improved processing temperature latitude. Such sulfonamidophenol reducing agents can be prepared employing known procedures in the art and include such compounds as described in Canadian Pat. 815,526 of Bard, issued June 17, 1969. One especially useful class of sulfonamidophenol reducing agents is represented by the formula:



wherein R<sup>6</sup> is phenyl, naphthyl, methylphenyl, thienyl, quinolinyl, thiazyl, or alkyl containing 1 to 4 carbon atoms, such as methyl, ethyl, propyl or butyl; R<sup>4</sup> is hydrogen, R<sup>5</sup>SO<sub>2</sub>NH—, alkoxy containing 1 to 4 carbon atoms, such as methoxy, ethoxy, propoxy and butoxy, bromine or chlorine; R<sub>5</sub> is hydrogen, bromine, chlorine, alkyl containing 1 to 4 carbon atoms, as described, or alkoxy containing 1 to 4 carbon atoms, such as methoxy, ethoxy and propoxy. R<sup>4</sup>, R<sup>5</sup> and/or R<sup>6</sup> can contain substituent groups which do not adversely affect the reducing properties of the described sulfonamidophenol reducing agents or the desired sensitometric properties of the photothermographic elements and materials of the invention. Examples of substituent groups which can be present are alkyl containing 1 to 3 carbon atoms such as methyl, ethyl and propyl, chlorine, bromine and phenyl. In some cases, it is desirable to avoid an amino group as a substituent. The amino group, in some cases, provides an overly active reducing agent. Sulfonamidophenol reducing agents, as

described, include sulfonamidonaphthols. A sulfonamidonaphthol which is useful is represented by the formula:



The sulfonamidophenol group in the described sulfonamidonaphthols can be in the ortho, meta or para position. The sulfonamidonaphthols and sulfonamidophenols which contain two sulfonamidophenol groups are more active compounds within the sulfonamido reducing agent class. The sulfonamidophenols are employed for shorter developing times or with heavy metal salt oxidizing agents which are less active than silver behenate. In some cases image discrimination provided by photothermographic materials containing the sulfonamidonaphthols and trifunctional sulfonamidophenols is less than that provided by other of the described sulfonamidophenols.

The described N-hydroxynaphthalimide activator-toning agents can be employed in photothermographic elements and materials in a range of concentration. An optimum concentration will depend upon the particular photothermographic material, the oxidation-reduction image forming components, the photosensitive component, processing conditions and the like. A typically useful range of concentration is a concentration of from about 0.001 mole to about 0.5 mole of the described activator-toning agent per mole of total silver in the photothermographic element or composition. A preferred concentration range is a concentration of activator-toning agent of from about 0.002 mole to about 0.05 mole of activator-toning agent per mole of total silver in the photothermographic element or composition.

The described N-hydroxynaphthalimide activator-toning agents can be used in combination with other activator-toning agents if desired. A typical suitable activator-toning agent with which the described N-hydroxynaphthalimide activator-toning agents can be employed is described in Belgian Pat. 766,590 issued June 15, 1971. Typical activator-toning agents include, for example, phthalimide, N-hydroxyphthalimide, N-potassium phthalimide, succinimide and/or N-hydroxysuccinimide. Other activator-toning agents which can be employed, in some cases, with the N-hydroxynaphthalimide compounds include phthalazinone, 2-acetylphthalazinone and the like.

It is desirable, in some cases, to employ an image stabilizer and/or image stabilizer precursor in the described elements of the invention. Typical image stabilizers or stabilizer precursors are described, for example, in Belgian Pat. 768,071 issued July 30, 1971. Typical stabilizer precursors include, for example, azole thioethers and blocked azoline thione stabilizer precursors as described in this Belgian patent.

A photothermographic element or composition, as described, according to the invention can contain various colloids alone or in combination as vehicles, binding agents and in various layers. Suitable materials can be hydrophobic or hydrophilic. They are transparent or translucent and include both naturally-occurring substances such as proteins, for example, gelatin, gelatin derivatives, cellulose derivatives, polysaccharides such as dextran, gum arabic and the like; and synthetic polymeric substances such as water soluble polyvinyl compounds like poly(vinyl pyrrolidone), acrylamide polymers and the like. Other synthetic polymeric compounds which can be employed include dispersed vinyl compounds such as in latex form and particularly those which increase dimensional stability of photographic materials. Effective polymers include water-insoluble polymers of alkyl acrylates and methacrylates, acrylic acid, sulfoalkyl acrylates, methacrylates and those which have crosslinking sites which facilitate hardening or curing as well as those having recurring sulfobetaine units as described in Canadian Pat. 774,054. Especially

useful high molecular weight materials and resins include poly(vinyl butyral), cellulose acetate butyrate, poly(methyl methacrylate), poly(vinyl pyrrolidone), ethylcellulose, polystyrene, polyvinyl chloride, chlorinated rubber, polyisobutylene, butadiene-styrene copolymers, vinyl chloride, vinyl acetate copolymers, copolymers of vinyl acetate, vinyl chloride and maleic acid and polyvinyl alcohol.

An especially useful photothermographic element according to the invention comprises a support having thereon (a) photosensitive silver halide, (b) an oxidation-reduction image forming combination comprising (i) silver behenate and/or silver stearate, with (ii) 2,6-dichloro-4-benzenesulfonamidophenol or 4-benzenesulfonamidophenol, (c) an N-hydroxynaphthalimide accelerator-toning agent as described, such as N-hydroxy-1,8-naphthalimide, and (d) a polymeric binder, such as poly(vinyl butyral).

A range of reducing agent can be employed in the described photothermographic element and/or composition of the invention. A useful concentration of reducing agent is typically from about 0.2 mole to about 2.0 moles of reducing agent per mole of silver halide in the photothermographic element and/or composition. A useful concentration of reducing agent in relation to oxidizing agent, such as silver behenate or silver stearate, is typically from about 0.01 mole to about 20 moles of reducing agent per mole of oxidizing agent, such as per mole of silver behenate. When reducing agents are employed in combination, the total concentration of reducing agent is typically within the described concentration range.

Photothermographic elements according to the invention can contain development modifiers that function as speed-increasing compounds, hardeners, antistatic layers, plasticizers and lubricants, coating aids, brighteners, spectral sensitizing dyes, absorbing and filter dyes, also as described in the Product Licensing Index, vol. 92, December 1971, publication 9232, pp. 107-110.

The photothermographic elements according to the invention can comprise a wide variety of supports. Typical supports include cellulose nitrate film, cellulose ester film, poly(vinyl acetal) film, polystyrene film, poly(ethylene terephthalate) film, polycarbonate film and related films or resinous materials, as well as glass, paper, metal and the like supports which can withstand the processing temperatures employed according to the invention. Typically a flexible support is employed.

Another embodiment of the invention is a photothermographic composition comprising (a) a photosensitive component, typically photosensitive silver salt, such as photosensitive silver halide, with (b) an oxidation-reduction image forming combination comprising (i) a heavy metal salt oxidizing agent as described with (ii) a reducing agent, as described, and (c) a polymeric binder, also as described, such as poly(vinyl butyral). An example of such a photothermographic composition comprises (a) photosensitive silver halide, (b) an oxidation-reduction image forming combination comprising (i) silver behenate and/or silver stearate, with (ii) a sulfonamidophenol reducing agent, as described, such as 2,6-dichloro-4-benzenesulfonamidophenol and/or 4-benzenesulfonamidophenol, (c) an activator-toning agent which is N-hydroxynaphthalimide and (d) a polymeric binder, such as poly(vinyl butyral).

The photothermographic compositions and other compositions according to the invention can be coated on a suitable support by various coating procedures including dip coating, air knife coating, curtain coating or extrusion coating using hoppers such as described in U.S. Pat. 2,681,294 of Beguin, issued June 15, 1954. If desired, two or more layers can be coated simultaneously such as described in U.S. Pat. 2,761,791 of Russell, issued Sept. 4, 1956, and British Pat. 837,095.

Spectral sensitizing dyes can be used in the described photothermographic elements and compositions of the in-

vention to confer additional sensitivity to the elements and compositions of the invention. Useful sensitizing dyes are described, for example, in the Product Licensing Index, vol. 92, December 1971, publication 9232, pp. 107-110, par. XVI.

After exposure of the described photothermographic element according to the invention, typically to visible light the resulting latent image can be developed merely by overall heating the element to moderately elevated temperatures. This merely involves heating the described photothermographic element overall from about 80° C. to about 250° C. such as for about 0.5 second to about 60 seconds. By increasing or decreasing the length of time of heating, a higher or lower temperature within the described range can be employed depending upon the desired image. Typically a lower processing temperature is desired. A preferred processing temperature range is from about 115° C. to about 150° C. A developed image is typically produced within several seconds, such as from about 0.5 second to about 60 seconds.

Any suitable means can be used for providing the desired processing temperature range. The heating means can be a simple hot plate, iron, roller or the like.

Processing is usually carried out under ambient conditions of pressure and humidity. Conditions outside normal atmospheric pressure and humidity can be employed, if desired.

If desired, one or more components of the photothermographic element can be in one or more layers of the element. For example, in some cases it can be desirable to include certain percentages of the reducing agent, activator toner, image stabilizer and/or stabilizer precursor in a protective layer over the photothermographic element. This, in some cases, can reduce migration of certain addenda in the layers of the photothermographic element.

A thermographic element and/or composition can be provided with the described components omitting the photosensitive component. A thermographic element with the described components comprises a support having thereon an oxidation-reduction image forming combination comprising a heavy metal salt oxidizing agent with a reducing agent and an N-hydroxynaphthalimide activator toning agent as described. For example, a thermographic element employing this combination comprises a support having thereon an oxidation-reduction image forming combination comprising silver behenate and/or silver stearate with a sulfonamidophenol reducing agent such as 2,6'-dichloro-4-benzenesulfonamidophenol and/or 4-benzenesulfonamidophenol, with N-hydroxynaphthalimide. An image is provided on the described thermographic element by imagewise heating the material. Such imagewise heating is described, for example, in U.S. Pat. 2,910,377 of Owen, issued Oct. 27, 1959, and U.S. Pat. 2,740,896 of Miller, issued Apr. 3, 1956.

The following examples are included for a further understanding of the invention.

#### EXAMPLE 1

The following components are mixed:

Silver behenate	g	42.0
Behenic acid	g	32.0
Poly(vinyl butyral)	g	15.0
Acetone-toluene (1:1 by volume)	ml	500

After ball-milling this mixture for 18 hours, then 75 ml. of an acetone solution containing 1% by weight of lithium bromide is added. The resulting composition is stirred for several minutes. This is designated as Dispersion A. Two milliliters of this Dispersion A containing 0.38 millimoles of silver are mixed with the following:

2,2' - dihydroxy - 1,1' - binaphthyl: 72 mg. (0.26 millimoles).

N-hydroxy-1,8-naphthalimide: Concentration given in Table I.

The resulting composition is diluted to 10 cc. by adding acetone-toluene (1:1 parts by volume) to the composition. The 10 cc. composition is then coated on a 5-inch by 18-inch polyethylene coated paper support. The coating is permitted to dry in air to provide a photothermographic element. The photothermographic element is sensitometrically exposed to tungsten light through a high contrast object. The resulting latent image is developed by overall heating the photothermographic element by contacting the side of the element opposite the described coating with a heated metal block at 150° C. for the time designated in Table I. The maximum and minimum reflection density which results in each instance is given in Table I.

TABLE I

Millimoles of N-hydroxy-1,8-naphthalimide	Time (sec.)	D <sub>max.</sub>	D <sub>min.</sub> <sup>1</sup>
0.0016	20	0.10	0.08
0.0032	20	0.11	0.07
0.0053	16	0.56	0.09
0.011	8	0.83	0.09
0.021	7	0.99	0.14
0.037	7	0.87	0.17
0.04	4	0.97	0.08
0.08	5	1.02	0.08
0.16	4	1.10	0.12

<sup>1</sup> Density of paper support is 0.06.

A difference between maximum and minimum density of 0.02 can be suitable, although higher difference between these is preferred.

#### EXAMPLE 2

This is a comparative example.

The procedure set out in Example 1 is repeated with the exception that phthalimide is employed in place of N-hydroxy-1,8-naphthalimide and the concentration employed is as set out in following Table II. Time of processing, maximum and minimum reflection densities provided are also given in Table II.

TABLE II

Millimoles of phthalimide	Time (sec.)	D <sub>max.</sub>	D <sub>min.</sub> <sup>1</sup>
0.12	30	0.19	0.13
0.24	20	0.50	0.14

<sup>1</sup> Density of paper support is 0.06.

It is found that N-hydroxy-1,8-naphthalimide provides surprisingly higher maximum density than phthalimide without significantly higher minimum density at similar concentrations and employing the same processing conditions. The advantages of the activator-toners of the invention include higher activity than phthalimide, shorter processing time and desired effectiveness at lower concentrations.

#### EXAMPLES 3-8

The procedure set out in Example 1 is repeated with the exception that phthalimide or N-hydroxy-1,8-naphthalimide as set out in Table III is employed at the concentration of 0.005, 0.01 or 0.02 millimole per 0.38 millimole of silver in the Dispersion A. Also, 0.50 millimole of 2,2'-dihydroxy-1,1'-binaphthyl is employed. The photothermographic element in each instance is exposed and processed as in Example 1 with the exception that the temperature of the heated metal block is 135° C. The results are given in Table III.

TABLE III

Ex.	Compound	Millimole of compound (per 0.38 millimole Ag)	Time (sec.)	D <sub>max.</sub>	D <sub>min.</sub> <sup>1</sup>
3	Phthalimide	0.005	15	0.11	0.09
4	N-hydroxy-1,8-naphthalimide (invention)	0.005	15	0.38	0.08
5	Phthalimide	0.01	15	0.13	0.10
6	N-hydroxy-1,8-naphthalimide (invention)	0.01	7	0.62	0.07
7	Phthalimide	0.02	15	0.13	0.08
8	N-hydroxy-1,8-naphthalimide (invention)	0.02	7	0.66	0.10

<sup>1</sup> Density of paper support is 0.06.

At equal concentrations of so-called accelerator-toning agent the photothermographic element of the invention provides surprisingly increased maximum density in reduced processing time.

#### EXAMPLES 9-11

This illustrates combination of so-called accelerator-toning agents of the invention.

The procedure set out in Example 1 is repeated with the exception that a concentration of the so-called accelerator-toning agents set out in following Table IV are employed. After sensitometric exposure of the photothermographic element, the resulting latent image is developed by overall heating the element as described in Example 1 with the exception that the heated metal block is at 135° C. Time of processing and the density produced is set out in Table IV.

TABLE IV

Example number	Concentration of phthalimide	Concentration of N-hydroxy-1,8-naphthalimide	Time (sec.)	D <sub>max.</sub>	D <sub>min.</sub>	Comment
9	18 mg. (0.12 mmols)	0.6 mg. (0.0032 mmols)	20	0.11	0.10	Very weak image.
10	18 mg. (0.12 mmols)	0.6 mg. (0.0032 mmols)	25	0.12	0.12	Do.
11	18 mg. (0.12 mmols)	0.6 mg. (0.0032 mmols)	25	0.62	0.11	Good image discrimination of warm neutral tone.

Processing temperature latitude of a photothermographic material, in many cases, can also be enhanced by the addition of small concentrations of mercury salts, such as mercuric acetate. The addition of small concentrations of mercury salts for this purpose is especially useful in photothermographic materials containing a non-gelatin, polymeric peptized photosensitive silver halide composition as a photosensitive component. A useful concentration is typically from about  $4 \times 10^{-5}$  moles to about 0.08 mole of mercury salt, such as mercuric acetate, per mole of heavy metal salt oxidizing agent, especially silver behenate. The mercury salts can be used with an oxidation-reduction image forming combination as described.

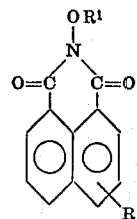
When employing mercury salts, such as mercuric acetate, it can be useful to prepare the photothermographic material by mixing a solution (A) containing a long-chain fatty acid, such as behenic acid, in a suitable solvent, such as ethanol and triethylamine, with a solution (B) containing silver nitrate in a suitable solvent, such as ethanol and acetonitrile, and a solution (C) containing a polymeric binder, such as poly(vinyl butyral), and a mercury salt, such as mercury acetate, in a suitable solvent, such as ethanol to prepare a silver behenate dispersion. The silver behenate dispersion can be mixed with a source of halide ions to prepare photosensitive silver halide and the resulting composition can be mixed with a reducing agent, such as 2,2'-dihydroxy-1,1'-binaphthyl, and an activator-toning agent, also known as an accelerator-toning agent, such as phthalimide or N-hydroxy-1,8-naphthalimide. This composition can be mixed with other addenda, such as a sensitizing dye, and coated on a suitable support to provide a photothermographic element. This can be imagewise exposed and the resulting latent image developed by overall heating the element as described.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

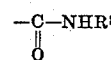
What is claimed is:

1. In a photothermographic element comprising a support having thereon a photosensitive component, an oxidation-reduction image forming combination comprising a heavy metal oxidizing agent with a reducing agent, and an imide activator-toner and a binder, the improvement wherein said imide activator-toner comprises an N-hydroxynaphthalimide activator-toner.

2. A photothermographic element as in claim 1 wherein said N-hydroxynaphthalimide activator-toner is a compound represented by the formula:



wherein R<sup>1</sup> is hydrogen or



wherein R<sup>3</sup> is alkyl containing 1 to 4 carbon atoms or phenyl, R<sup>2</sup> is hydrogen, alkyl containing 1 to 4 carbon atoms, hydroxy, methoxy, chlorine, bromine or iodine.

3. A photothermographic element as in claim 1 wherein said N-hydroxynaphthalimide activator-toner is N-hydroxy-1,8-naphthalimide.

4. A photothermographic element comprising a support having thereon photosensitive silver halide, an oxidation-reduction image forming combination comprising silver behenate with the bis-beta-naphthol reducing agent and N-hydroxy-1,8-naphthalimide.

5. A photothermographic element comprising a support having thereon photosensitive silver halide, an oxidation-reduction image forming combination comprising silver behenate with a sulfonamidophenol reducing agent and N-hydroxy-1,8-naphthalimide.

6. A photothermographic element as in claim 5 wherein said N-hydroxynaphthalimide activator-toners comprises about 0.001 mole to about 0.5 mole of said activator-toner per mole of silver in said photothermographic element.

7. In a photothermographic composition comprising a photosensitive component, an oxidation-reduction image forming combination comprising a heavy metal salt oxidizing agent with a reducing agent, an imide activator-toner and a binder, the improvement wherein said imide activator-toner comprises an N-hydroxynaphthalimide activator-toner.

8. A photothermographic composition as in claim 7 wherein said N-hydroxynaphthalimide activator-toner is N-hydroxy-1,8-naphthalimide.

9. A photothermographic composition comprising photosensitive silver halide, an oxidation-reduction image forming combination comprising silver behenate with a bis-beta-naphthol reducing agent, N-hydroxy-1,8-naphthalimide and a poly(vinyl butyral) binder.

10. A photothermographic composition comprising photosensitive silver halide, an oxidation-reduction image forming combination comprising silver behenate with a sulfonamidophenol reducing agent, N-hydroxynaphthalimide and a poly(vinyl butyral) binder.

11. The photothermographic composition of claim 10 comprising about 0.01 to about 20 moles of photosensitive silver halide, about 0.2 to about 20 moles of said reducing agent, and about 0.001 to about 0.05 mole of N-hydroxynaphthalimide per mole of silver behenate in said photothermographic composition.

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12. A process of developing a latent image in a photo-thermographic element comprising a support having thereon a photosensitive component, an oxidation-reduction image forming combination comprising an oxidizing agent with a reducing agent, an N-hydroxynaphthalimide activator-toner, and a binder, comprising heating said element to about 80° C. to about 250° C.

13. The process of claim 12 wherein said element is heated from about 80° to about 250° C. for about 0.5 second to about 60 seconds.

14. A process of developing a latent image in a photo-thermographic element comprising a support having thereon photosensitive silver halide, an oxidation-reduction image forming combination comprising silver behenate with a bis-beta-naphthol reducing agent, N-hydroxy-1,8-naphthalimide, and a poly(vinyl butyral) binder, comprising heating said element from about 115° C. to about 150° C. for about 0.5 to about 30 seconds.

15. A thermographic element comprising a support having thereon an oxidation-reduction image forming combination comprising a heavy metal salt oxidizing agent with a reducing agent and an N-hydroxynaphthalimide activator-toner.

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16. A thermographic element comprising a support having thereon an oxidation-reduction image forming combination comprising silver behenate with a sulfonamidophenol reducing agent and N-hydroxy-1,8-naphthalimide.

17. A thermographic composition comprising an oxidation-reduction image forming combination comprising a heavy metal salt oxidizing agent with a reducing agent and an N-hydroxynaphthalimide activator-toner.

18. A thermographic composition comprising an oxidation-reduction image forming combination comprising silver behenate with a sulfonamidophenol reducing agent and N-hydroxy-1,8-naphthalimide.

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96—114.1, 114.6

UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,782,941 Dated January 1, 1974

Inventor(s) Paul Hartman and Gale E. Smith

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 11, "N-hydroxnaphthalimide" should read ---N-hydroxynaphthalimide---. Line 20, "a" should be inserted after "in". Line 50, "Licesing" should read ---Licensing---. Line 61, "oxiding" should read ---oxidizing---. Line 62, "oxidizings" should read ---oxidizing---. Line 64, "of" should read ---to---.

Column 4, line 4, "benenate" should read ---behenate---. Line 5, "N-hydroxnaphthalimide" should read ---N-hydroxynaphthalimide---. Line 14, that part of the formula reading "6,6'-dinitoro" should read ---6,6-dinitro---. Line 17, "polyhydroxybenezenes" should read ---polyhydroxybenzenes---. Line 22, "hydroquione" should read ---hydroquinone---. Line 37, "McLean" should read ---McLaen---.

Column 5, line 11, "sulfonamidonaphthols" should read ---sulfonamidonaphthols---.

Column 6, line 42, "poly(ethyene" should read ---poly(ethylene---.

Column 7, line 5, "XVI" should read ---XV---.

In the Claims:

Column 10, line 45, "activator-toners" should read ---activator-toner---. Line 73, "mole" should read ---moles---.

Column 11, line 22, "reducting" should read ---reducing---.

Signed and sealed this 27th day of August 1974.

(SEAL)

Attest:

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