

**A LOW IGNITION PROPENSITY CIGARETTE HAVING
OXYGEN DONOR METAL OXIDE IN THE CIGARETTE WRAPPER**

FIELD OF THE INVENTION

5 This invention relates to free-burn rate control of a burning cigarette and more particularly, to cigarettes which have low ignition propensity and when set down are capable of self-extinguishing for purposes of safety.

BACKGROUND OF THE INVENTION

10 Various attempts have been made in controlling cigarette free-burn rate particularly with a view to developing a reduced ignition propensity or self-extinguishing cigarette. Such features of low ignition propensity or self-extinguishment are believed to be safety features. For example, self-extinguishment of the cigarette can reduce the chances of starting a fire
15 should the cigarette fall on combustible material, such as furniture coverings and the like. Most commonly free-burn rate modifiers are added to the conventional cigarette papers to affect the free-burn rate. The free-burn rate can be reduced to a level where the cigarette self-extinguishes if the cigarette falls onto a surface and is left idle for an extended period of time, such as two
20 minutes or more. An example of such a cigarette is described in Canadian Patent 1,211,021, wherein the wrapper has a low porosity, contains one or more free-burn rate-retarding substances, and is substantially free of a burn promoter. Another example has been described in U.S. Patent 4,622,983, wherein the low ignition propensity cigarette has a wrapper with a Burn Mode
25 Index of 1.5 cm^{-1} to 5.0 cm^{-1} and a burn promoter such as an alkali metal salt of a carboxylic acid.

 Alternatively, a free-burn rate reducing material may be applied as a band to the cigarette paper, which will provide low ignition propensity if it is left to burn into the banded area of free-burn rate reduction material.
30 Examples of such a system are described in U.S. Patents 5,474,095, 5,417,228, 5,263,999, 4,739,775, 4,452,259, and 4,044,778 and U.S. Patent Application 2002/0179105.

More specifically, U.S. Patent Application 2002/0179105 describes a low ignition propensity cigarette having a base wrapper with an untreated area and at least one discrete area treated with a composition to control the free-burn rate. The composition comprises a permeability reducing
5 substance (e.g. starch and cellulose), a free-burn rate retarding substance (e.g. phosphates of ammonium) and a free-burn rate accelerating substance (e.g. alkali metal or alkaline-earth metal salts of carboxylic acids).

European Patent Application 559,300 describes a wrapper for a conventional cigarette or an aerosol cigarette. The wrapper of the
10 conventional cigarette may be coated with a band of a gel of selected metal oxides as a free-burn rate retarding substance.

U.S. Patent 4,739,775 describes a wrapper for a cigarette. The wrapper includes a normal burning cellulose fiber base web and one or more bands of a cellulose fiber base web that has a Burn Mode Index of between 0
15 cm^{-1} and 4.0 cm^{-1} , wherein the cigarette is self-extinguishing in the banded areas.

U.S. Patents 5,474,095, 5,417,228, and 5,263,999 describe a low ignition propensity cigarette having a wrapper with regions of cellulosic material applied thereto to reduce the free-burn rate of the cigarette.

20 In contrast, U.S. Patent 4,615,345 describes a self-extinguishing cigarette with a wrapper made of a cellulose fiber base, which provides the low ignition propensity, and the wrapper further includes zones of burn promoter. The material is an alkali metal burn promoter such as a potassium salt of citric acid.

25 Other alternatives are described in U.S. Patents 2,666,437 and 4,638,819, which provide a ring or the like on a cigarette, which will extinguish the cigarette once the free-burning coal approaches the ring. Another common mechanism for extinguishing the cigarette is to provide a tubular device into which the cigarette is inserted to self-extinguish the burning coal.
30 Such a device is described in U.S. Patent 1,581,451.

In addition, U.S. Patent 4,945,932 describes a self-extinguishing cigarette with a wrapper that comprises areas with lesser and greater air permeability in the form of patterned zones.

Most of these systems have in common the feature of reducing free-burn rate by using free-burn rate modifiers, which are consumed during the combustion of the cigarette. The consumption of the free-burn rate modifier may adversely affect various characteristics of the cigarette such as side-stream smoke, flavour, taste, and ash characteristics of the cigarette.

SUMMARY OF THE INVENTION

In a low ignition propensity cigarette having a self-extinguishing cigarette wrapper which is capable of self-extinguishing the cigarette, the use in accordance with an aspect of this invention of an oxygen storage and donor metal oxide with the cigarette wrapper to support and maintain free-burn of the self-extinguishing cigarette while retaining the low ignition propensity property of a self-extinguishing cigarette wrapper.

In accordance with another aspect of the invention, in a low ignition propensity cigarette having a tobacco rod and a wrapper surrounding the tobacco rod and having a base permeability, the wrapper comprising an untreated area and at least one discrete area treated with a composition to reduce the base permeability so that as a coal of a burning cigarette advances along the treated area, the cigarette self-extinguishes if placed on a surface,

the improvement comprising: the composition having the oxygen storage and donor oxidation metal oxide to support and maintain the burning coal as it advances along the treated area.

In accordance with another aspect of the invention, a banded low ignition propensity cigarette comprises a tobacco rod wrapped with a cigarette paper, the wrapper has at least one band encompassing the wrapper. The band is formed from a free-burn rate control composition to provide a low ignition propensity cigarette. The composition comprises a porosity reducing agent and an oxygen storage and donor metal oxide.

In accordance with another aspect of the invention, a low ignition propensity cigarette comprises a tobacco rod wrapped with a cigarette wrapper. The wrapper has a low porosity level for self-extinguishing the burning tobacco rod. The wrapper has circumferential zones of an oxygen storage and donor metal oxide to support a free-burn rate which maintains free-burn of the tobacco rod along the zones.

In accordance with another aspect of the invention, a method of extinguishing a cigarette when set down on a surface, the method comprises allowing an advancing burning cigarette coal to burn into the band of a cigarette wrapper which reduces free burn rate to a level which self-extinguishes the cigarette if it remains on the surface, the band comprising the oxygen storage and donor metal oxide in an amount which supports free burn of the burning coal advancing through the band while retaining the self-extinguishing property of the cigarette wrapper.

In accordance with another aspect of the invention, in a low ignition propensity cigarette, which is capable of self-extinguishing, the use of an oxygen storage and donor metal oxide with the cigarette wrapper to support and maintain free burn of the self-extinguishing cigarette while retaining the low ignition propensity property of the self-extinguishing cigarette, the cigarette comprising a tobacco rod having a tobacco density which is capable of self-extinguishing the cigarette and the wrapper having circumferential zones of the oxygen storage and donor metal oxide to support a free burn rate which maintains free burn of the tobacco rod along the zones.

In accordance with another aspect of the invention, a low sidestream smoke cigarette having low ignition propensity properties, the cigarette comprising a wrapper about a tobacco rod. The wrapper having a composition which reduces sidestream smoke from a burning cigarette and comprises, in combination, an oxygen storage and donor metal oxide catalyst and an essentially non-combustible finely divided porous particulate adjunct for the catalyst. The sidestream smoke reducing composition reducing porosity of the wrapper to render the cigarette as self-extinguishable. The oxygen storage and donor metal oxide catalyst is in an amount which supports free burn of the cigarette while retaining the self-extinguishing

property of the cigarette wrapper.

In accordance with another aspect of the invention, a low sidestream smoke cigarette having low ignition propensity properties comprising a wrapper about a tobacco rod. The wrapper having a composition which
5 reduces sidestream smoke from a burning cigarette and comprises, in combination, an oxygen storage and donor metal oxide catalyst and an essentially non-combustible finely divided porous particulate adjunct for the catalyst. The sidestream smoke reducing composition reducing porosity of the wrapper to render the cigarette as self-extinguishable. The wrapper
10 having a circumferential zone of the oxygen storage and donor metal oxide catalyst to support a free burn rate along the zone without self-extinguishing.

In accordance with a further aspect of the invention, a wrapper of the above aspects of the invention for reducing sidestream smoke and/or providing for self-extinguishment of the cigarette.

15 In accordance with yet a further aspect of the invention, a double wrap self-extinguishing cigarette having an inner and an outer wrapper. One of the inner and outer wrapper comprises an oxygen storage and donor metal oxide to support and maintain free-burn of a self-extinguishing cigarette while retaining the low ignition propensity property of a self-extinguishing cigarette
20 wrapper.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In most types of low ignition propensity cigarettes, there are two competing mechanisms. From a low ignition propensity standpoint, whenever a cigarette is set down, such as on upholstery, cloth, bed linen or other solid
25 surfaces, the cigarette should self-extinguish almost immediately. From a smoker's perspective a low ignition propensity cigarette should not self-extinguish during the normal smoking of the cigarette. Normal smoking of a cigarette includes lighting the cigarette, puffing on the cigarette anywhere from six to ten times where the cigarette stays lit between puffs and continues
30 with acceptable free-burn between puffs unless set down on a solid surface.

In accordance with this invention, the use of an oxygen storage and donor metal oxide functions very well in balancing these two mechanisms to provide a low ignition propensity cigarette which has acceptable free-burn or

static-burn properties. Free-burn or static-burn implies burning of a cigarette while idling between smoker's fingers, sitting on an edge of an ashtray or the like. The oxygen donor metal oxide supports the combustion of the cigarette but does not accelerate combustion of the cigarette in the manner that prior art burn accelerators do. The oxygen storage and donor metal oxide of this invention is not consumed in the reaction, instead simply has a change of oxidation state during which oxygen is released as it changes oxidation states and then when it changes back to its' original state, picks up the oxygen from surroundings. As such, the oxygen donor metal oxide is not consumed in the reaction, thereby remaining in the cigarette ash. The oxygen storage and donor metal oxide functions as a source of oxygen which is released in a controlled manner as the metal oxide changes oxidation states so that the oxygen supports the free-burn of the cigarette and is not consumed in the reaction as are burn accelerants, such as citrates. By virtue of oxygen being released from the oxygen storage and donor metal oxide, there is greater opportunity to design a self-extinguishing cigarette which has more predictable low ignition propensity properties so as to self-extinguish when set down.

The oxygen storage and donor metal oxide performs a very beneficial function in a low ignition propensity cigarette by supporting and maintaining a desired free-burn for a self-extinguishing cigarette. The oxygen donor material contributes oxygen to provide for free-burn so that the cigarette fire coal continues to advance along the cigarette. The oxygen donor material overcomes the burn retarding activities of the low porosity cigarette wrapper and/or high density tobacco rod. Not only is it possible to provide a self-extinguishing cigarette by providing a wrapper, which either contributes to or controls the self-extinguishing feature, but alternatively, the tobacco rod can also be designed to provide a self-extinguishing cigarette. For example, the tobacco rod may be manufactured to include, along its length, higher density portions, which burn more slowly and self-extinguish if left unattended for any length of time. A higher density for the tobacco rod may be employed throughout the length of the tobacco rod or sections of the tobacco rod may have higher density to slow down and, if unaided by an oxygen donor source,

self-extinguishes the cigarette. It is understood that a combination of tobacco rod density and cigarette paper modifications can be employed to provide a cigarette with a balanced low ignition propensity property and a desired free-burn property. In most situations, an acceptable free-burn in a low ignition propensity cigarette is that the cigarette remains lit for a period of time, greater than 30 seconds through to about 4 minutes. The preferred free-burn time is usually greater than about 1.5 minutes, and most preferably greater than about 2 minutes when set down on a surface. Although, on average, a smoker puffs on the cigarette every minute to one and a half minutes, a low ignition propensity cigarette preferably remains lit for greater than about two minutes of static burn or free-burn.

In accordance with a preferred embodiment of this invention, a cigarette paper is made by applying thereto or incorporating therein, a composition which greatly reduces the porosity of the paper. This reduction in porosity of the paper may be due to the addition to the paper of a desired constituent for treating mainstream or sidestream smoke, for example, the addition of a high surface area component such as metal oxides or the like. Such paper is of such low porosity that when lit, it almost immediately extinguishes. In accordance with an aspect of this invention, added to the paper is an oxygen donor which supports combustion of the tobacco. The oxygen donor material is applied to the paper in a way that it is included along the paper to provide a combustion rate for a pre-determined period of time such that the burning coal temperature is lowered and will provide for self-extinguishment if the cigarette is set down on a surface. Alternatively, the oxygen donor composition is applied as zones, such as the zones described in U.S. Patent 4,615,345, to the paper to provide annular zones along the cigarette paper which sustain free-burn adjacent annular bands of cigarette paper which are self-extinguishing. Based on normal or conventional smoking techniques with approximately 8 to 10 puffs per cigarette, the zones are approximately 15 to 25 mm in length along the cigarette and the bands are approximately 2 to 10 mm in length.

The oxygen donor material may be applied to the paper by either incorporation or impregnation in the paper along the length of the paper or applied in zones or bands, such as by coating or impregnation. If the wrapper is a double wrapper, the inner or outer wrapper may be treated with the

5 porosity reducing agents so as to become self-extinguishing and then either in the inner wrapper or the outer wrapper, oxygen donor material is used to support free-burn of the cigarette to the extent desired. The oxygen donor material is preferably applied on an outer wrapper which places the oxygen donor material adjacent the outside face of the inner wrapper. The coating or

10 impregnation of the wrapper with the treatment composition to provide the self-extinguishing bands does not add appreciably to the thickness of the wrapper. Although it is understood that some of the treatment compositions may include porosity reducing agents which may add to the thickness of the paper, such as bands of cellulose as described in U.S. Patent 5,740,095.

15 In accordance with an aspect of this invention, the free-burn rate control mechanism is provided by adding or including a selected amount of oxygen donor material such as cerium oxide with a very slow burning cigarette paper. The oxygen donor material is surprisingly effective in supplying sufficient oxygen to support the desired extent of combustion. In

20 the absence of the oxygen donor material or at reduced levels thereof, the cigarette self-extinguishes due to low ignition propensity when set down on a upholstered furniture or the like. A balance is then achieved between these competing mechanisms in using sufficient oxygen storage donor metal oxide to support and maintain the desired free-burn of the self-extinguishing

25 cigarette while at the same time retaining the desired low ignition propensity property of the self-extinguishing cigarette.

In accordance with a preferred embodiment of the invention, an adsorbent may be applied to or incorporated into the cigarette paper to achieve certain desired results in the treatment of mainstream or sidestream

30 smoke. By virtue of incorporating such materials, the porosity of the paper may approach zero. Normally this paper would be useless although, surprisingly in accordance with this invention, the use of an oxygen donor such as cerium oxide supplies sufficient oxygen to permit the non-porous

paper to burn. A predetermined amount of cerium oxide, for example, in the range of about 10% to 15% by weight of the paper may be used. The amount of cerium oxide is sufficient to support combustion for up to about two minutes before the cigarette self-extinguishes. Alternatively, much higher concentrations of cerium oxide may be applied to the cigarette paper as zones which supply sufficient oxygen to promote free-burn rate through the zone of cerium oxide material. Once the burning coal enters the region where there is no oxygen storage and donor material or very little of such material, the cigarette coal temperature drops dramatically to self-extinguish and provide a low ignition propensity cigarette. Typical basis weights of these papers is about 20 to 125 g/m². On a percentage of dry weight of the wrapper, the amount of oxygen storage and donor metal oxide may range from about 5 to 60% by weight. A more preferred range is from about 10 to 50% by weight of the paper and the most preferred range is from about 10 to 30% by weight of the paper.

The oxygen storage and donor metal oxide may perform other functions such as an oxidation catalyst. The use of the term catalyst emphasizes that the oxygen donor oxidation catalyst may change oxidation state to release an oxygen molecule, but the catalyst is not consumed in the reaction.

Specific examples of the oxygen donor material include oxygen storage and donor metal oxide oxidation catalyst, such as, transition metal oxides, rare earth metal oxides, a solid solution of mixed metal oxides, and mixtures thereof. In particular, the transition group consists of oxides from Group IVB, VB, VIB, VIIB, VIII, IB metals and mixtures thereof. Preferred rare earth metal oxides are selected from the group consisting of oxides of scandium, yttrium, lanthanide metals and mixtures thereof. Preferably the lanthanide metals include lanthanum, cerium, praseodymium, neodymium and mixtures thereof. The preferred lanthanide metal oxide is cerium oxide or its precursor ceria sol.

In addition, the oxygen donor may also be a high surface material such as cerium oxide in particulate form or mixed solid solutions of cerium oxide with other constituents such as cerium/zirconium oxides. The zirconium

oxides may also be used in particulate form with the oxygen donor material. Other suitable particulate materials include tin oxides, titanium oxides, magnesium oxides, alumina, low surface area cerium oxide, calcium carbonate and mixtures thereof. The mixed solid solution of metal oxides
5 includes any combination such as, cerium/lanthanum mixed oxides, cerium/zirconium mixed oxides, cerium/aluminum mixed oxides, cerium/magnesium mixed oxides, cerium/titanium mixed oxides, cerium/zirconium/lanthanum mixed oxides, cerium/lanthanum mixed oxide, cerium/zirconium mixed oxide, cerium/zirconium/lanthanum mixed oxide,
10 cerium/zirconium/praseodymium mixed oxide, cerium/zirconium/lanthanum/praseodymium mixed oxide, cerium/zirconium/neodymium mixed oxide.

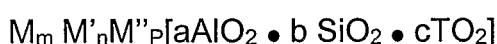
Various fillers may be incorporated in the cigarette paper to augment the effectiveness of the oxygen donor, for example, the adsorbents in combination with the oxygen donor, provide for a reduction in visible
15 sidestream smoke. Suitable adjuncts for the oxygen donor material include any suitable, essentially non-combustible finely divided particulate material which does not affect the flavour and taste of the mainstream smoke and does not give off any undesirable odours in the sidestream vapours. The adjunct may be of low surface area, usually in excess of $5 \text{ m}^2/\text{g}$ through to
20 high surface area porous adjuncts having surface areas greater than $20 \text{ m}^2/\text{g}$. The porous adjunct may have pores with an average diameter of less than 100 nm ($1000 \text{ \AA}$). More preferably, the pores have an average diameter of less than 20 nm ($200 \text{ \AA}$) and even more preferred are pores with an average diameter of 0.5 to 10 nm (5 - $100 \text{ \AA}$). With zeolite based materials, the pores
25 have an average diameter in the range of about 0.5 to 1.3 nm (5 - $13 \text{ \AA}$).

The particulate adjunct may have an average particle size of less than about $30 \mu\text{m}$, more preferably less than about $20 \mu\text{m}$ and most preferably less than $1 \mu\text{m}$ up to about $5 \mu\text{m}$. Non-combustible materials may be porous clays of various categories commonly used in cigarette paper manufacture, such as
30 the bentonite clays or treated clays having high surface areas. Non-combustible carbon materials may also be used including milled porous carbon fibres and particulates. Various metal oxides may be used such as porous monolithic mineral based materials which include zirconium oxide,

titanium oxides, cerium oxides, aluminum oxides such as alumina, metal oxide fibres such as zirconium fibres and other ceramics such as milled porous ceramic fibres and mixtures thereof. In respect of cerium oxide, it has been found that it is capable of functioning as a finely divided adjunct and as an oxygen storage and donor cerium oxide oxidation catalyst. Other adjunct materials include high surface area materials such as activated carbon and zeolites.

The adjunct may also comprise high surface area highly sorptive materials which are non-combustible, inorganic finely divided particulate, such as molecular sieves which include zeolites and amorphous materials such as silica/alumina and the like. Zeolites such as silicalite zeolites, faujasites X, Y and L zeolites, beta zeolites, Mordenite zeolites and ZSM zeolites are acceptable. Preferred zeolites include hydrophobic zeolites and mildly hydrophobic zeolites which have affinity for hydrophobic and mildly hydrophobic organic compounds of such sidestream smoke whereby water vapour is avoided. The zeolite materials provide a highly porous structure which selectively absorbs and adsorbs components of sidestream smoke. The highly porous structure generally comprise macropores amongst the particles and micropores within the particles which branch off of the macropores.

The zeolite materials may be characterized by the following formula:



wherein

- M is a monovalent cation,
- M' is a divalent cation,
- M'' is a trivalent cation,
- a, b, c, n, m, and p are numbers which reflect the stoichiometric proportions,
- c, m, n or p can also be zero,
- Al and Si are tetrahedrally coordinated Al and Si atoms, and
- T is a tetrahedrally coordinated metal atom being able to replace Al or Si, wherein the ratio of b/a of the zeolite or the zeolite-like material, has a value of about 5 to 300 and the micropore size is within the range of

about 0.5 to 1.3 nm (5 to 13Å).

Preferred zeolites of the above formula, have the specific formulas of faujasites ((Na₂, Ca, Mg)₂₉[Al₅₈Si₁₃₄O₃₈₄] · 240 H₂O; cubic), β-zeolites (Na_n[Al_nSi_{64-n}O₁₂₈] with n<7; tetragonal), Mordenite zeolites (Na₈[Al₈Si₄₀O₉₆] · 24 H₂O; orthorhombic), ZSM zeolites (Na_n[Al_nSi_{96-n}O₁₉₂] ~ 16 H₂O with n<27; orthorhombic), and mixtures thereof.

It is appreciated that various grades of the sorptive material may be used. This is particularly true with gradients of zeolites which can be custom designed to selectively adsorb, for example, high boiling point materials, mid boiling point materials and low boiling point materials. This can lead to layers of the zeolite composition where the cerium oxide or other suitable catalyst contemplated by this invention is preferably dispersed throughout these layers. The layers may then be bound on cigarette paper for the tobacco rod by using a binder or an adhesive which may be, for example, polyvinylacetate, polyvinyl alcohol, carboxy methyl cellulose (CMC), starches and casein or soya proteins, and mixtures thereof.

The adjuncts and fillers may include metal oxides, metal salts as ash conditioners, calcium carbonate, zeolites, mixed metal oxides, binding clays, inorganic binders, milled fibers, monolithic mineral based materials and non-combustible activated carbon. The binders and adjunct for the catalysts may be used as porosity reducing agents. These porosity reducing agents may be incorporated into the paper during the manufacture to develop low porosity paper or may be coated on conventional cigarette paper to reduce the paper porosity. With most low ignition propensity cigarettes the porosity is usually less than 10 Coresta units and may in some circumstances drop as low as 0 Coresta units. It is also understood that in conditioning the ash of the cigarette, conventional additives such as ash conditioners may be used. Common ash conditioners are carbonates such as calcium, metal salts of carboxylic acids and phosphates of ammonium. Examples of the carboxylic acid salts include alkali metal and alkali earth metal, salts of acidic acid, citric acid, maleic acid, lactic acid, tartaric acid and the like.

Suitable phosphates of ammonia include monoammonium phosphate, diammonium phosphate, diammonium hydrogen orthophosphate,

diammonium salt of phosphoric acid and ammonium hydrogen phosphate. Also, typical fillers that contribute to ash conditioning include the usual clays, calcium carbonate, titanium oxide, zirconium oxide, titanium oxide, magnesium oxide, aluminum oxide, cerium oxide, tin oxide, iron oxide,
5 manganese oxide, calcium carbonate, zirconium carbonate, magnesium carbonate and the like.

The addition of adjuncts in combination with the oxygen donor to achieve desired characteristics such as reduction of sidestream smoke can greatly decrease the porosity of the cigarette paper. By choosing a functional
10 amount of oxygen donor material, the low porosity paper can still burn. However, from the standpoint of a fire-safe cigarette, the amount of oxygen donor selected is such to reduce the cigarette burning coal temperature to provide a low ignition propensity cigarette. If the cigarette is set down, it may self-extinguish after a predetermined period of time, usually no more than four
15 minutes. This aspect of the invention provides a significant advance in allowing one to design a low porosity paper for enhancing a characteristic of the cigarette and then using an oxygen storage and donor metal oxide to maintain a desired reduced free-burn rate.

The oxygen donor material may be incorporated in the manufacture of
20 the paper, applied as a coating to the paper or impregnated in the paper. Alternatively, the oxygen donor material may be applied as zones, such as the zones described in U.S. Patent 4,615,345, to the paper to provide conventional free-burn rate regions for the cigarette adjacent slow free-burn rate which result in self-extinction of the cigarette should it be left idle on a
25 surface. Various methods are available for either applying the composition to a low porosity paper as an incorporation, coating, impregnation or as a band of material. Coating, incorporation or impregnation may be achieved in the manner described in applicant's co-pending International Patent Application WO 02/024005, the subject matter of which is incorporated herein by
30 reference.

The banding or application of the oxygen donor as zones on the cigarette paper may be achieved by a plurality of transversely moving nozzles which move across the cigarette paper as it is being manufactured to apply

spaced apart zones of oxygen donor material to the low porosity paper.

When the paper is slit and rolled the somewhat spiral-shaped zones meet up to define spaced apart zones of normal burn rate promoting composition with intermediate areas of low porosity paper. The zone which provides for normal
5 or conventional free-burn rate is usually in the range of about 15 mm to 25 mm in length and most preferably are about 20 mm to about 22 mm. The band of slow burning material may be designed to self-extinguish the cigarette, if it is not puffed, are of a width of about 2 mm to about 10 mm in length, preferably over 5 mm.

10 The paper may be double-wrapped on a cigarette where the inner layer of paper contains the oxygen donor material to provide for low ignition propensity and the outer paper is provided to enhance ash characteristics of the low porosity inner paper, such as described in applicant's co-pending PCT application Serial No. PCT/CA03/00353 filed March 14, 2003 and entitled
15 "Low Sidestream Smoke Cigarette With Combustible Paper Having a Modified Ash", the subject matter of which is incorporated herein by reference. Other possible configurations for the double wrap cigarette include providing on the inner wrapper a sidestream smoke treatment composition which provides an inner wrapper with a low porosity level for self-
20 extinguishing burning cigarette tobacco rod. Although the outer wrapper may serve an ash conditioning function, it may also be provided with circumferential zones of the oxygen storage and donor metal oxide to support the desired free-burn rate which maintains free-burn of the tobacco rod along the zones. Alternatively, in conjunction with the sidestream smoke control
25 material on the inner wrapper, zones of oxygen donor material may be provided to maintain the desired free-burn rate. In the alternative to the zones, it is also understood that sufficient oxygen donor material may be used along the entire length of the inner wrapper to maintain the desired free-burn rate.

30 In accordance with an aspect of this invention, a judicious selection of cerium oxide with an adjunct can provide sidestream smoke control as well as a fire-safe cigarette. An oxygen donor starved composition for controlling sidestream smoke may be provided in a base paper. Zones of normal

sidestream smoke control composition as described in the aforementioned International Patent Application WO 02/024005, having increased amounts of oxygen donor material may be applied to support conventional free-burn rates for the cigarette in those zones or regions. The intervening portions which are
5 oxygen donor starved, self-extinguish the cigarette if the cigarette is not puffed on within a predetermined time, for example, within two to four minutes. Alternatively, a sidestream smoke control composition can be applied or used in the low porosity base paper where the amount of oxygen donor is at a reduced level to ensure that the cigarette self-extinguishes when
10 set down within a predetermined period of time, for example, within two to four minutes.

The wrapper for the tobacco rod is usually conventional cigarette paper that has been modified to have a base permeability which is sufficiently low that the coal of the burning cigarette advances along the tobacco rod and
15 self-extinguishes when placed on a solid surface or where the cigarette was left unattended for a period of time in excess of two to three or four minutes. The preferred base permeability of the wrapper is usually less than 10 Coresta units, preferably less than 6 Coresta units and may even approach 0 Coresta units. A reduction in porosity may be in predetermined bands or
20 along the length of the cigarette paper. As noted, various porosity reducing agents can be applied to the bands to reduce porosity to a desired level. The porosity reducing agent may have alternate functions, as described hereinbefore but also, may comprise additional cellulose layered onto the paper to provide bands of decreased porosity which will self-extinguish. The
25 band of cellulose may include oxygen storage and donor metal oxide to provide for desired free-burn of the band such that the band burns for a predetermined period of time but will self-extinguish if left idle before the fire cone passes through the band. Examples of bands of cellulose used in providing bands of reduced porosity are described for example in the
30 aforementioned U.S. Patent 5,740,095. The predetermined period of time is preferably greater than or equal to about 2 minutes.

In balancing the amount of oxygen donor material in a low porosity cigarette, the free-burn rate of the cigarette usually results in a higher puff

count. The puff count may be in excess of ten and perhaps twelve to sixteen puffs per conventional length of cigarette. By virtue of this invention, one can take advantage of the benefits of an oxygen storage and donor metal oxide in combination with a porosity reducing agent to develop a cigarette having

5 significantly shorter tobacco rods, usually at least 1/3 shorter by virtue of the slower free-burn with the shorter tobacco rod. The desired conventional puff count of six to ten puffs is then achieved. One third less tobacco used in a cigarette equates to considerable cost savings in the manufacturing and sale of cigarettes. This is a significant benefit in the use of the oxygen storage and

10 donor metal oxide because of the controlled release of the oxygen, the desired free-burn along the length of the shortened tobacco rod is realized.

In achieving the correct balance and the amount of oxygen storage and donor metal oxide, which is preferably an oxidation catalyst is usually determined by trial and error. There are many parameters which can affect

15 porosity of the wrapper material, each of them responding differently to the use of an oxygen donor. As previously mentioned, a self-extinguishing time of less than 30 seconds is usually not acceptable for a commercial cigarette. The industry is proposing that a self-extinguishing time of less than two minutes is also not acceptable. Sufficient oxygen donor is used to increase

20 the self-extinguishment period preferably beyond about two minutes.

A conventional cigarette will smoulder without extinguishment until all combustible tobacco is consumed. A low ignition propensity cigarette on the other hand self extinguishes anywhere from about 30 seconds to four minutes. Those skilled in the art will understand that the predetermined time

25 before the cigarette self-extinguishes depends at least in part on wrapper parameters. Those wrapper parameters include the width of the band, the porosity of the base web, the spacing of the band, the length of the free-burn zones and additives used to improve ash and the like. By a trial and error method, a predetermined time for extinguishment can therefore be designed

30 into the wrapper by experimentation with these parameters.

Although preferred embodiments of the invention have been described herein in detail, it will be understood by those skilled in the art that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.

CLAIMS:

1. In a low ignition propensity cigarette having a self-extinguishing cigarette wrapper which is capable of self-extinguishing the cigarette, the use
5 of an oxygen storage and donor metal oxide with the cigarette wrapper to support and maintain free burn of the self-extinguishing cigarette while retaining the low ignition propensity property of the self-extinguishing cigarette wrapper.
- 10 2. The cigarette of claim 1, having
a tobacco rod and
a wrapper surrounding the tobacco rod and having a base permeability, the wrapper comprising
an untreated area and
15 at least one discrete area treated with a composition to reduce the base permeability so that as a coal of a burning coal advances along the treated area, the cigarette self-extinguishes if placed on a surface,
the improvement comprising:
20 said composition having said oxygen storage and donor oxidation metal oxide to support and maintain said burning coal as it advances along the treated area.
- 25 3. The cigarette of claim 2, wherein said at least one discrete area is at least one band encompassing said wrapper, said band being formed from a free burn rate control composition to provide a low ignition propensity cigarette, said composition comprising a porosity reducing agent and said oxygen storage and donor metal oxide.
- 30 4. The cigarette of claim 1, comprising a tobacco rod wrapped with said cigarette wrapper, said wrapper having a low porosity for self-extinguishing the burning tobacco rod, said wrapper having circumferential zones of said

oxygen storage and donor metal oxide to support a free burn rate which maintains free burn of said tobacco rod along said zones.

5. A method of extinguishing the cigarette of claim 3 when set down on a surface, the method comprising allowing an advancing burning cigarette coal to burn into said band of a cigarette wrapper which reduces free burn rate to a level which self-extinguishes said cigarette if it remains on said surface, said band comprising said oxygen storage and donor metal oxide in an amount which supports free burn of said burning coal advancing through said band while retaining said self-extinguishing property of said cigarette wrapper.

6. A self-extinguishing cigarette wrapper which is capable of self-extinguishing a cigarette, the cigarette wrapper comprising an oxygen storage and donor metal oxide to support and maintain free burn of a self-extinguishing cigarette while retaining the low ignition propensity property of a self-extinguishing cigarette wrapper.

7. The self-extinguishing cigarette wrapper of claim 6, wherein said wrapper has a base permeability, said wrapper comprising an untreated area and at least one discrete area treated with a composition to reduce the base permeability so that as a coal of a burning coal advances along the treated area, the cigarette self-extinguishes if placed on a surface, said composition comprising said oxygen storage and donor oxidation metal oxide, which supports and maintains said burning coal as it advances along the treated area.

8. The self-extinguishing cigarette wrapper of claim 7 wherein said at least one discrete area is at least one band encompassing said wrapper, said band being formed from a free burn rate control composition to provide a low ignition propensity cigarette, said composition comprising a porosity reducing agent and said oxygen storage and donor metal oxide.

9. The self-extinguishing cigarette wrapper of claim 6, wherein said wrapper has a low porosity for self-extinguishing a burning tobacco rod, said wrapper having circumferential zones of said oxygen storage and donor metal oxide to support a free burn rate which maintains free burn of a tobacco rod
5 along said zones.

10. In a low ignition propensity cigarette, which is capable of self-extinguishing, the use of an oxygen storage and donor metal oxide with the cigarette wrapper to support and maintain free burn of the self-extinguishing
10 cigarette while retaining the low ignition propensity property of the self-extinguishing cigarette, the cigarette comprising a tobacco rod having a tobacco density which is capable of self-extinguishing said cigarette and said wrapper having circumferential zones of said oxygen storage and donor metal oxide to support a free burn rate which maintains free burn of said tobacco
15 rod along said zones.

11. The invention of claim 1, 2, 4, 6, 7, or 9, wherein said wrapper comprises a porosity reducing agent which lowers porosity of said wrapper to a level to self-extinguish the cigarette.
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12. The invention of claim 3, 5, 8 or 11, wherein said porosity reducing agent is selected from the group consisting of metal oxides, starch, metal salts as ash conditioners, soya, guar gums, calcium carbonate, zeolites, mixed metal oxides, polyvinylalcohol, carboxymethylcellulose, casein, binding
25 clays, inorganic binders, milled fibers, monolithic mineral based materials, non-combustible activated carbon, and mixtures thereof:

13. The invention of claim 3, 5, 8 or 11, wherein said porosity reducing agent is an additional layer of cellulose on said wrapper, said additional layer
30 being in the form of a circumferential band about said wrapper.

14. The invention of claim 1, 2, 3, 4 or 5, wherein a tobacco rod for said cigarette is shorter than conventional tobacco rod lengths to provide a conventional number of puffs.

5 15. The invention of any one of claims 1 to 9, wherein said oxygen storage and donor metal oxide is an oxidation catalyst selected from the group consisting of transition metal oxides, rare earth metal oxides, a solid solution of mixed metal oxides, and mixtures thereof.

10 16. The invention of any one of claims 1 to 9, wherein said cigarette wrapper is non-combustible or combustible.

17. The invention of claim 15, wherein said transition metal oxides are selected from the group consisting of oxides of group IVB, VB, VIB, VIIB, VIII,
15 IB metals and mixtures thereof.

18. The invention of claim 17, wherein said transition metal oxides are selected from the group consisting of oxides of iron, copper, silver, manganese, titanium, zirconium, vanadium and tungsten.

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19. The invention of claim 15, wherein said rare earth metal oxides are selected from the group consisting of oxides of scandium, yttrium, lanthanide metals and mixtures thereof.

25 20. The invention of claim 19, wherein said lanthanide metal oxides are selected from the group consisting of lanthanum oxide, cerium oxide, praseodymium oxide, neodymium oxide and mixtures thereof.

21. The invention of claim 20, wherein ceria sol is a precursor for cerium
30 oxide.

22. The invention of claim 15, wherein said solid solution of mixed metal oxides is selected from the group consisting of cerium/lanthanum mixed oxide, cerium/zirconium mixed oxide, cerium/ zirconium/lanthanum mixed oxide, cerium/zirconium/praseodymium mixed oxide,
5 cerium/zirconium/lanthanum/praseodymium mixed oxide, cerium/zirconium/neodymium mixed oxide and mixtures thereof .

23. The invention of claim 22, wherein said solid solution is a high surface area porous particulate.

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24. The invention of claim 23, wherein said solid solution is cerium/zirconium mixed oxide having a ratio ranging from about 5:95 to about 95:5.

15 25. The invention of claim 24, wherein said ratio is about 75:25 and said particle size is about 6 μm to 10 μm .

26. The invention of claim 1, 2, 4, 6, 7, 8, or 9, wherein said oxygen storage and donor metal oxide is a coating on said cigarette paper, is
20 impregnated into said cigarette paper, or is incorporated into said cigarette paper during cigarette paper manufacture.

27. The invention of claim 3, 5, 11, 12, or 13, wherein said oxygen storage and donor metal oxide and said porosity reducing agent is a coating on
25 said cigarette paper, is impregnated into said cigarette paper, or is incorporated into said cigarette paper during cigarette paper manufacture.

28. The invention of claim 15, wherein said oxygen storage and donor
30 metal oxide is a finely divided particulate with an average particle size less than about 30 μm .

29. A low sidestream smoke cigarette having low ignition propensity properties, said cigarette comprising a wrapper about a tobacco rod, said wrapper having a composition which reduces sidestream smoke from a burning cigarette and comprises in combination, an oxygen storage and donor metal oxide catalyst and an essentially non-combustible finely divided porous particulate adjunct for said catalyst, said sidestream smoke reducing composition reducing porosity of said wrapper to render said cigarette as self-extinguishable, said oxygen storage and donor metal oxide catalyst being in an amount which supports free burn of said cigarette while retaining said self-extinguishing property of said cigarette wrapper.

30. A low sidestream smoke wrapper having a composition which reduces sidestream smoke from a burning cigarette and comprises in combination, an oxygen storage and donor metal oxide catalyst and an essentially non-combustible finely divided porous particulate adjunct for said catalyst, said sidestream smoke reducing composition reducing porosity of said wrapper to render said cigarette as self-extinguishable, said oxygen storage and donor metal oxide catalyst being in an amount which supports free burn of said cigarette while retaining said self-extinguishing property of said cigarette wrapper.

31. The invention of claim 29 or 30, wherein said oxygen storage and donor metal oxide catalyst is throughout said wrapper.

32. The invention of claim 29 or 30, wherein circumferential zones of said wrapper have said oxygen storage and donor metal oxide catalyst.

33. The invention of claim 29 or 30, wherein said porosity of said wrapper is less than 10 Coresta units.

34. The invention of claim 29 or 30, wherein said adjunct is selected from the group consisting of clays, essentially non-combustible milled fibres,

monolithic mineral based materials, essentially non-combustible activated carbon, zeolites and mixtures thereof.

35. The invention of claim 29 or 30, wherein said catalyst is selected from
5 the group consisting of transition metal oxides, rare earth metal oxides, a solid solution of mixed metal oxides and mixtures thereof.

36. The invention of claim 35, wherein said transition metal oxides are
selected from the group consisting of oxides of group IVB, VB, VIB, VIIB, VIII,
10 IB metals and mixtures thereof.

37. The invention of claim 36, wherein said transition metal oxides are
selected from the group consisting of oxides of iron, copper, silver,
manganese, titanium, zirconium, vanadium and tungsten.
15

38. The invention of claim 35, wherein said rare earth metal oxides are
selected from the group consisting of oxides of scandium, yttrium, lanthanide
metals and mixtures thereof.

20 39. The invention of claim 38, wherein said lanthanide metal oxides are
selected from the group consisting of lanthanum oxide, cerium oxide,
praseodymium oxide, neodymium oxide and mixtures thereof.

40. The invention of claim 39, wherein ceria sol is a precursor for cerium
25 oxide.

41. The invention of claim 39, wherein a metal or metal oxide oxidation
catalyst is used with said cerium oxide, said metal or metal oxide being
selected from the group of oxides of precious metals, transition metals, rare
30 earth metals, metals from groups IIA, IVA, and mixtures thereof.

42. The invention of claim 41, wherein said selected metal or metal oxide is platinum, palladium, copper oxide, iron oxide, magnesium oxide, silver oxide, or mixtures thereof.

5 43. The invention of claim 35, wherein said oxygen storage and donor metal oxide catalyst for the solid solution being selected from the group consisting of lanthanum oxide, cerium oxide, praseodymium oxide, neodymium oxide and mixtures thereof.

10 44. The invention of claim 43, wherein said mixed metal oxides are selected from the group of metal oxides consisting of zirconium oxide, aluminum oxide, magnesium oxides, titanium oxide and mixtures thereof.

15 45. The invention of claim 44, wherein said solid solution of mixed metal oxides further comprising an oxidation catalyst selected from the group consisting of palladium, platinum, rhodium, tin oxide, copper oxide, iron oxide, manganese oxide and mixtures thereof.

20 46. The invention of claim 45, wherein said solid solution of mixed metal oxides is selected from the group consisting of cerium/lanthanum mixed oxide, cerium/zirconium mixed oxide, cerium/ zirconium/lanthanum mixed oxide, cerium/zirconium/praseodymium mixed oxide, cerium/zirconium/lanthanum/praseodymium mixed oxide, cerium/zirconium/neodymium mixed oxide and mixtures thereof .

25 47. The invention of claim 46, wherein said solid solution is a high surface area porous particulate.

30 48. The invention of claim 47, wherein said solid solution is cerium/zirconium mixed oxide having a ratio ranging from about 5:95 to about 95:5.

49. The invention of claim 48, wherein said ratio is about 75:25 and said particle size is about 6 μm to 10 μm .

50. The invention of claim 29 or 30, wherein said catalyst is present in an amount which supports free-burn for greater than about two minutes and self-extinguishes in less than about four minutes.

51. The invention of claim 29, wherein a tobacco rod for said cigarette is shorter than conventional tobacco rod cigarette lengths to provide a conventional number of puffs.

52. The invention of claim 39, wherein a first amount of cerium oxide in said treatment composition is said adjunct and a second amount of said cerium oxide in said treatment composition is said catalyst.

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53. The invention of claim 29 or 30, wherein said oxygen storage and donor metal oxide catalyst and said essentially non-combustible finely divided porous particulate adjunct for said catalyst is a coating on said cigarette wrapper, is impregnated into said cigarette wrapper, or is incorporated into said cigarette paper during cigarette wrapper manufacture.

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54. The invention of claim 29 or 30, further comprising an ash modifying material is selected from the group consisting of zirconium oxide, titanium oxide, magnesium oxide, aluminum oxide, cerium oxide, tin oxide, iron oxide, manganese oxide, calcium carbonate, zirconium carbonate, magnesium carbonate and mixtures thereof.

25

55. The invention of claim 46, wherein said oxygen storage and donor metal oxide and said adjunct is said high surface area cerium/zirconium mixed oxide.

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56. The invention of claim 55, wherein zirconium oxide and/or a zeolite are used in combination with said cerium/zirconium mixed oxide.

57. The invention of claim 29 or 30, wherein said adjunct has an average particle size of less than about 30 μ m.

58. The invention of claim 29 or 30, wherein said adjunct is a high surface area material with a surface area in excess of about 20 m²/g and an average particle size greater than about 1 μ m.

59. The invention of claim 34, wherein said zeolite is selected from the group consisting of silicalite zeolites, faujasites, X, Y and L zeolites, beta zeolites, Mordenite zeolites, ZSM zeolites and mixtures thereof.

60. The invention of claim 35, wherein said oxygen storage and donor metal oxide is a finely divided particulate with an average particle size less than about 30 μ m.

61. The invention of claim 35, wherein said oxygen storage and donor metal oxide has a particle size less than about 1.0 μ m when said oxygen storage and donor metal oxide particles are fixed to surfaces of said adjunct.

62. A double wrap self-extinguishing cigarette and having an inner and an outer wrapper, one of said inner and outer wrapper comprising an oxygen storage and donor metal oxide to support and maintain free burn of a self-extinguishing cigarette while retaining the low ignition propensity property of a self-extinguishing cigarette wrapper.

63. A cigarette of claim 62, wherein said inner wrapper comprises a sidestream smoke reducing composition and said outer wrapper comprises said oxygen storage and donor metal oxide.

64. A cigarette of claim 62, wherein said inner wrapper has a low porosity for self-extinguishing a burning cigarette tobacco rod and said outer wrapper has circumferential zones of an oxygen storage and donor metal oxide to

support a free burn rate which maintains free burn of said tobacco rod along said zones.

65. A cigarette of claim 64, wherein said inner wrapper has a porosity
5 reducing agent selected from the group consisting of metal oxides, starch, metal salts as ash conditioners, soya, guar gums, calcium carbonate, zeolites, mixed metal oxides, polyvinylalcohol, carboxymethylcellulose, casein, binding clays, inorganic binders and mixtures thereof.

10 66. A cigarette of claim 65, wherein said inner wrapper has a sidestream smoke reducing composition which reduces porosity of said inner wrapper to a level which provides self-extinguishment.

15 67. A cigarette of claim 66, wherein said sidestream smoke reducing composition comprises in combination an oxygen storage and donor metal oxide catalyst and an essentially non-combustible finely divided porous particulate adjunct for said catalyst.

20 68. A cigarette of claim 67, wherein said porosity of said inner wrapper is less than 10 Coresta units.

25 69. A cigarette of claim 68, wherein said adjunct is selected from the group consisting of clays, essentially non-combustible milled fibres, monolithic mineral based materials, essentially non-combustible activated carbon, zeolites and mixtures thereof.

30 70. A cigarette of claim 67, wherein said catalyst is selected from the group consisting of transition metal oxides, rare earth metal oxides, a solid solution of mixed metal oxides and mixtures thereof.

71. A cigarette of claim 70, wherein said rare earth metal oxides are selected from the group consisting of oxides of scandium, yttrium, lanthanide metals and mixtures thereof.

72. A cigarette of claim 71, wherein said lanthanide metal oxides are selected from the group consisting of lanthanum oxide, cerium oxide, praseodymium oxide, neodymium oxide and mixtures thereof.

5 73. A cigarette of claim 72, wherein ceria sol is a precursor for cerium oxide.

10 74. A cigarette of claim 70, wherein said solid solution of mixed metal oxides is selected from the group consisting of cerium/lanthanum mixed oxide, cerium/zirconium mixed oxide, cerium/ zirconium/lanthanum mixed oxide, cerium/zirconium/praseodymium mixed oxide, cerium/zirconium/lanthanum/praseodymium mixed oxide, cerium/zirconium/neodymium mixed oxide and mixtures thereof.