

Brief Report

Tobacco Industry Strategies to Minimize or Mask Cigarette Smoke: Opportunities for Tobacco Product Regulation

Ryan David Kennedy, Ph.D.,^{1,2} Rachel A. Millstein, M.H.S.,^{1,3} Vaughan W. Rees, Ph.D.,¹ & Gregory N. Connolly, D.M.D., M.P.H.¹

¹ Center for Global Tobacco Control, Society, Human Development, and Health, Harvard School of Public Health, Boston, MA

² Propel Centre for Population Health Impact, University of Waterloo, Waterloo, Canada

³ Clinical Psychology Department, San Diego State University/University of California San Diego, San Diego, CA

Corresponding Author: Vaughan Rees, Ph.D., Center for Global Tobacco Control, Department of Society, Human Development, and Health, Harvard School of Public Health, 677 Huntington Avenue Landmark Building, 3rd Floor, East Boston, MA02115, USA. Telephone: 617-496-1395; Fax: 617-495-8543; E-mail: vrees@hsph.harvard.edu

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Abstract

Introduction: The tobacco industry has developed technologies to reduce the aversive qualities of cigarette smoke, including secondhand smoke (SHS). While these product design changes may lessen concerns about SHS, they may not reduce health risks associated with SHS exposure. Tobacco industry patents were reviewed to understand recent industry strategies to mask or minimize cigarette smoke from traditional cigarettes.

Methods: Patent records published between 1997 and 2008 that related to cigarette smoke were conducted using key word searches. The U.S. Patent and Trademark Office web site was used to obtain patent awards, and the World Intellectual Property Organization's Patentscope and Free Patents Online web sites were used to search international patents.

Results: The search identified 106 relevant patents published by Japan Tobacco Incorporated, British America Tobacco, Philip Morris International, and other tobacco manufacturers or suppliers. The patents were classified by their intended purpose, including reduced smoke constituents or quantity of smoke emitted by cigarettes (58%, $n = 62$), improved smoke odor (25%, $n = 26$), and reduced visibility of smoke (16%, $n = 18$). Innovations used a variety of strategies including trapping or filtering smoke constituents, chemically converting gases, adding perfumes, or altering paper to improve combustion.

Conclusions: The tobacco industry continues to research and develop strategies to reduce perceptions of cigarette smoke, including the use of additives to improve smoke odor. Surveillance and regulatory response to industry strategies to reduce perceptions of SHS should be implemented to ensure that the public health is adequately protected.

Introduction

Both smokers and non-smokers report concerns with the physical presence of secondhand smoke (SHS); they consider the smell unpleasant and take steps to avoid exposure (Pilkington, Gray, Gilmore, & Daykin, 2006; Kaufman, Griffin, Cohen, Perkins, & Ferrence, 2010; Eckler, 2011). In the 1990s, prior to the widespread adoption of clean indoor air laws, public concerns about lingering SHS odors on clothing were as common as reported concerns about the health consequences of SHS exposure (Biener & Fitzgerald, 1999). The heightened public knowledge of SHS health effects, and demand for smoke-free spaces provided a motivation for the tobacco industry to produce cigarettes that reduced the aversive qualities of SHS (Begany, 2000). Since the 1970s, tobacco companies have created and sold a variety of cigarette products that incorporate patented design features and/or additives to disguise cigarette smoke by reducing odor or visibility, thus rendering the smoke less unpleasant both to smokers and to non-smokers (Connolly, Wayne, Lymperis, & Doherty, 2000; Ling & Glantz, 2005).

Tobacco manufacturers have used the term "less smoke smell" (LSS) to promote cigarettes designed to reduce SHS odor or visibility (Collier, 2008). In 2007 a Japan Tobacco Inc (JTI) subsidiary, JTI-Macdonald, introduced the brand Mirage to the Canadian market. JTI-Macdonald claimed that Mirage was the first brand in the country to use LSS Technology (Collier, 2008). Print ads promoting the brand explained that Mirage cigarettes had "less lingering tobacco smoke smell in an enclosed area when compared to a typical Canadian cigarette" (Tobacco International, 2008). The Mirage product used a flavorant described in the patent "Method of fixing flavorant which improves sidestream smoke smell of tobacco and cigarette," (Miyachi, Nagae,

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Tanabe, & Nakano, 2011). The patent describes the innovation as having a “smell-improving agent” comprising of an ethanol or propylene glycol solution applied to the cigarette paper. Tobacco control advocates in Canada were concerned that the Mirage brand, with its vanilla scented SHS, could potentially undermine efforts made to ensure people smoke outside their homes and vehicles so others are not exposed to SHS (CanWest News Service, 2007).

The first report on industry use of technologies and additives used to mask cigarette smoke included a history of these innovations as discovered through a review of internal industry documents and information from patents published up until 1996 (Connolly et al., 2000). No formal surveillance strategies for identifying and documenting the use of these technologies or additives, nor regulatory guidelines, have been introduced yet. Without formal disclosure by manufacturers, innovative strategies must be employed to gain a detailed understanding of cigarette design modifications. The extent to which the tobacco industry is engaged in developing innovations to mask or minimize cigarette smoke is not known.

The tobacco industry invests considerable financial and human resources into product research and development. Patents are filed to protect the ownership of innovations.

Patents provide detailed, publicly accessible information that describe the intended purpose of the technology, technical specifications, and the tobacco manufacturer or affiliate in whose name the patent is registered. The purpose of this study was to review and describe patented innovations developed by the tobacco industry to minimize or mask cigarette SHS from traditional cigarettes. This was done by searching patents issued since 1997.

Methods

The U.S. Patent and Trademark Office web site (www.uspto.gov) and Google Patents (www.google.com/patents) were used to obtain issued patent awards and published U.S. patent applications. The dates searched were restricted to only those issued from January 1, 1997 to December 31, 2008 (based on final issue publication date). This timeline was chosen to build on previous published work (Connolly et al., 2000). The World Intellectual Property Organization's Patentscope (www.wipo.int), Patent Storm (www.patentstorm.us), and Free Patents Online (www.freepatentsonline.com) web sites were used to identify international patents and applications. International patents found on these web sites were cross-checked with their home country patent office when available, including the UK Intellectual Property Office, (www.ipo.gov.uk), and Japan Patent Office (www.jpo.go.jp). Patents were identified using key word searches, including core terms such as “cigarette (or tobacco) smoke,” “sidestream smoke,” “secondhand smoke,” “less smoke smell,” “LSS,” “environmental tobacco smoke,” “sidestream odor,” “sidestream visibility,” “sidestream concentration,” and “sidestream irritation.” Derivations and synonyms of these terms were also used (e.g., low sidestream odor, low smoke smell, sidestream odor, and smoke AND tobacco AND visible). Further key word searches were performed using

relevant words or terms, including the names of patent authors. For example, using Google Patents key word search for “cigarette smoke less smell” identified 1,050 patents, and a search for “sidestream smoke” identified 667 patents. Different search terms and multiple search sites identified the same patents in some cases. A set of relevant patents was identified through this snowball sampling method and was then reviewed for relevance. All authors were involved in categorizing patents by the innovation's primary function.

Patents were considered relevant if the patent claimed the invention would reduce or mask cigarette smoke via one of the three major mechanisms: (a) reduced concentration or volume of emissions, (b) altered or improved smoke odor, or (c) reduced visibility of cigarette smoke.

Results

One hundred and six relevant patents registered during 1997–2008 that met the criteria used to identify cigarette smoke minimizing or masking technology. The patents discovered were held by many of the world's major tobacco manufacturers. JTI held the greatest number of patents identified (28), followed by British American Tobacco, who held 24 patents. Philip Morris (United States and international combined) held 23 patents, and Rothman's Benson & Hedges (operated as one company at the time of patent filings, now owned by Philip Morris International) held 22 patents. R. J. Reynolds Tobacco Company held 3 of the identified patents. The remaining patents ($n = 6$) were held by companies that supply paper products for cigarette manufacture, including Kimberly Clark Worldwide, Ohshiro Co., Ltd., and Reemstma GmbH.

Patents for technologies or processes designed to reduce smoke constituents or quantity of smoke emitted by cigarettes were most common (58%, $n = 62$), followed by improved cigarette smoke odor (25%, $n = 26$), and reduced visibility of SHS (17%, $n = 18$). Examples of patents are presented in Tables 1–3. Patents are presented based on their intended purpose, what part of the cigarette site(s) the innovation pertains to, and what general strategy is employed in the invention.

Patents Identified With Innovations to Reduce Smoke Constituents or Quantity of Smoke Emitted by Cigarette

A variety of smoke control systems have been patented which use filter material or adsorptive material. These alterations or additives are typically included in the filter, the paper wrapper, or in the tobacco (Snaidr, Becker, & Chapman, 2003). Of the patents identified in the present study, a variety of strategies described methods to reduce concentrations of specific constituents of smoke, including carbon monoxide, nitric oxide, or polycyclic aromatic hydrocarbons. Some strategies included adding nanoscale particles, or metal oxide, that act as catalysts to improve combustion. Many innovations dealt with altering cigarette paper by increasing porosity, or physically adding oxygen storage components. Paper alterations also included adding ceramics that could physically trap particulate matter, improving both odor and visibility.

Table 1. Examples of Patented Innovations to Reduce Smoke Constituents or Quantity of Smoke Emitted by Cigarettes

Site	Strategy and exemplar quotations:
Number of patents identified (<i>n</i> = 62)	
Cigarette paper or sheet material	<p>Mechanically trapping particulate: "...the wrapper comprising a ceramic material and being capable of mechanically trapping mainly aqueous particulate phase materials in the sidestream smoke, thereby reducing sidestream smoke deliveries considerably despite the use of the wrapper with conventional tobacco materials." (Bushby, McAdam, & Timms, 2001)</p> <p>Reducing sidestream smoke by increasing burn efficiency by treating paper: "A high surface area oxidative catalyst smoke suppressive composition, smoke suppressive articles, and method of making such compositions and articles are disclosed. The smoke suppressive composition is a solid solution comprising a mixture of iron (Fe) and magnesium (Mg) that promotes efficient combustion, articles treated with such compositions, and methods for making such smoke suppressive compositions and articles... The iron-magnesium composition demonstrates high surface area and efficient combustion for embodiments... The compositions provide superior smoke suppression for items such as cigarettes and smoke suppressive articles. The smoke suppressive compositions are particularly useful for reducing cigarette sidestream smoke in cigarettes." (Quincy & Cartwright, 1997)</p> <p>Material with other components to remove particles, aerosols and convert gases: "...the invention [uses] a treatment material in a process for treating cigarette sidestream smoke to remove visible smoke particles, aerosols and convert gases with off odours. Sheet material for application to a cigarette to reduce sidestream smoke... comprising substantially hydrophobic sorbent, sheet reinforcement and an oxygen storage component which releases oxygen at free-burn rate temperatures adjacent a burning coal of a cigarette...." (Bowen, Becker, Brackmann, & Snaird, 2004)</p>
Tobacco mix	<p>Addition of carbon particles to reconstituted tobacco: "Use in the tobacco rod of a smoking article of tobacco mixed with a reconstituted tobacco sheet which includes activated carbon particles, surrounded by a paper of... permeability of 20 coresta or greater results in an article having reduced sidestream smoke and selective reduction of certain ingredients in mainstream smoke, whereby the smoker has a perception of increased smoothness." (Sampson, 1999)</p>
Multi-site	<p>Reduction of carbon dioxide from mainstream smoke (catalyst): "The catalyst comprises nanoscale particles of palladium and/or palladium oxide incorporated in and/or on nanoscale particles of a metal or metal oxide. The nanoscale catalyst, which can be incorporated in the tobacco cut filler, cigarette wrapper and/or cigarette filter of a cigarette, is useful for low-temperature and near-ambient temperature catalysis. The nanoscale catalyst can convert carbon monoxide and nitric oxide that are found in mainstream smoke to carbon dioxide and nitrogen, respectively...." (El-Shall, 2006)</p> <p>Reduction of polycyclic aromatic hydrocarbons in mainstream and sidestream smoke (palladium): "An apparatus and method for the process of applying palladium salts to tobacco cut filler and other smokable products so that polycyclic aromatic hydrocarbons can be reduced in both mainstream and sidestream cigarette smoke." (Zimmerman & Baggett, 2008)</p>

Patented Innovations to Improve Smoke Odor From Cigarettes

Many patents included inventions with claims of improved cigarette smoke odor. The improvements were achieved either by masking the smell with perfumes, or neutralizing odors with additives such as mandarin orange essential oil. Innovations largely involved developing methods of applying perfumes to the parts of the cigarette in a form such that the odorants will not be emitted until the cigarette is burned or extinguished. In some instances, the invention relates to the cigarette wrapper, such as by increasing paper permeability or placing layers of paper with flavor additives in between to improve odor.

Patents Identified With Innovations to Reduce the Visibility of Cigarette Smoke

All of the patents identified that made claims to improve cigarette smoke visibility involved alterations or additives to the cigarette paper or wrapper material. Several patents described

how reduced visibility of cigarette smoke could be achieved by altering or reducing cigarette paper filler or including a high proportion of non-combustible inorganic material to the wrapper. Paper additives listed in the identified patents included calcium carbonate, oxygen storage and donor metal oxide catalysts. Many of the innovations to reduce the visible nature of cigarette smoke were similar to those that reduce the overall quantity of smoke, such as the inclusion of metal oxide catalysts or oxygen storage devices.

Discussion

The tobacco industry has continued to research and develop strategies to reduce perceptions of cigarette smoke. The inventions identified in the current study were patented by virtually all of the multinational cigarette manufacturers, suggesting that industry interest in technologies to alter the aversive qualities of SHS is broad. A range of product innovation strategies

Table 2. Examples of Patented Innovations to Improve Smoke Odor From Cigarettes

Site	Strategy and exemplar quotations:
Number of patents identified ($n = 26$)	
Paper	<p>Perfumes to improve odors:</p> <p>“A method of fixing a perfume for improving the odor of a secondary smoke issuing from a cigarette. The method comprises: applying to a cigarette paper a secondary-cigarette-smoke-odor improver obtained by adding an ethanol or propylene glycol solution of the perfume to an ethylene/vinyl acetate copolymer emulsion which has a solid content of 10 to 60 wt.% and in which the copolymer has an ethylene unit content of 30 wt.% or lower; and drying the paper to fix the perfume to the paper. The perfume solution in ethanol... the perfume solution in propylene glycol...” (Miyauchi, Nagae, Tanabe, & Nakano, 2001)</p> <p>Wrapper material permeability and flavour to alter odor:</p> <p>“The present invention relates to a smoking article comprising two layers of wrapper material, the outer wrapper having an air permeability of at least 200 C.U. and having a greater permeability than the inner wrapper. Encapsulated flavour is held between the inner and outer wrappers. The encapsulation technique is dependent upon the flavour to be encapsulated and the sidestream to mainstream flavour delivery ratio required. Sidestream smoke may be altered without altering the mainstream smoke, thereby altering room odours.” (Woods, 2004)</p> <p>Deodorizers and masking</p> <p>“...mandarin orange essential oil fraction having terpene hydrocarbons ... is effective for eliminating the tobacco odor, and ... is capable of masking the tobacco odor.... It is possible to coat the tip paper or a filter wrapper paper sheet with the sidestream smoke odor reducing agent of the present invention.” (Higashi et al., 2004)</p>
Filter capsule	<p>Neutralizing or masking of smoke smell:</p> <p>“This invention relates to the provision in a cigarette filter element of a capsule containing a deodorizer. The capsule is resistant to the handling endured before and during smoking, yet ruptures to release or expose the deodorizer upon extinguishing of the smoked cigarette. The deodorizer may comprise neutralizing or masking agents, or mixtures of both.” (MacAdam, O'Reilly, & Warren, 2007)</p>
Multi-site	<p>Regulator to reduce disagreeable smell:</p> <p>“A regulator for smoking flavor of tobacco comprising ascorbic acid, a salt or isomer thereof, and a chlorophyll-containing material, wherein a herb or a citrus fruit is further incorporated therein. The regulator can reduce the amount of tar and nicotine contained in tobacco smoke, can reduce a disagreeable smell or a pungent smell emitted at the time of smoking, such as an odor of nicotine, and can impart novel flavor to tobacco. It may be used in a state attached to the tip of tobacco, such as a cigarette, or in a state mixed in shredded tobacco leaves.” (Ohshiro, 1999)</p> <p>Vanillin:</p> <p>“There have been made numerous proposals for the incorporation in smoking articles, cigarettes for example, of compounds which effect a modification in the sensory perception pertaining to the mainstream and/or the sidestream smoke of the smoking articles. An agent commonly proposed for use as a smoke modifying agent is vanillin... The subject invention provides a method of modifying a smoking article, wherein vanillin glycoside is incorporated in a smoking article... In accordance with the subject invention the vanillin glycoside may be incorporated with one or more of: smoking material, wrapping material, filter material and wrapper adhesive.... The so released volatile vanillin is then effective to aromatise the mainstream and/or sidestream smoke of the smoking article.” (Dowle, 1997)</p>

were identified, including the addition of nanoscale particles of palladium to alter combustion, fix perfumes to cigarette paper, and help mask the smell of SHS. Although a substantial array of patented innovations was identified in this review, it is not easy to know whether these inventions have been incorporated into commercial products. It is also possible that companies file patents strategically to prevent the use of technology by commercial competitors, despite no intention of the company patent holder to actively use that technology (O'Connor et al., 2009).

The Family Smoking Prevention and Tobacco Control Act (2009) provides the U.S. Food and Drug Administration (FDA) with the authority to regulate the design and ingredients of tobacco products. The FDA can require the disclosure of design features, ingredients or additives that may adversely impact public health and the removal of these features of additives to protect public health.

Under Section 902 of the FSPTCA, a tobacco product may be deemed to be adulterated if “contaminated by any ... added deleterious substance that may render the product injurious to health.” If the added constituents that mask SHS odor or visibility are demonstrated to be injurious to health, products that employ such constituents might be considered contaminated.

Section 911 of the FSPTCA requires that no tobacco product implies, through advertising or other means, a lowered risk to consumers, unless it is demonstrated that the product significantly reduces harm and risk of tobacco related disease. It is conceivable that tobacco companies may develop cigarettes with reduced toxic smoke constituents using new technologies or additives and apply to have these considered modified risk tobacco products under section 911. To be approved, the cigarette manufacturer would need to demonstrate to the Secretary of Health and Human Services that such a product would promote public health, including that a measurable and substantial

Table 3. Examples of Patented Innovations to Reduce the Visibility of Cigarette Smoke

Site	Strategy and exemplar quotations:
Number of patents identified ($n = 18$)	
Paper	Ultrafine particles in wrapping material: <p>“In an embodiment, a wrapping material of the present invention comprises ultrafine particles distributed in a manner to provide substantially full coverage of the wrapping material by ultrafine particles....exploiting the sintering properties of ultrafine particles to form zones of reduced oxygen access and/or altered thermal properties; catalyzing reactions in the burning cigarette that modify the combustion process; exploiting the ability of ultrafine particles to alter combustion (e.g., in conjunction with water) and/or modifying the gross physical properties of the smoking articles (e.g. cigarettes) for example the ash structure and/or cigarette structure (e.g. cross-sectional shape, longitudinal shape).... cigarettes do not provide an undesirable off-taste and off-aroma to the mainstream and sidestream smoke generated thereby, and are capable of generating relatively low levels of visible sidestream smoke...” (Crooks, Sears, Cole, & Banerjee, 2004)</p> <p>Filler affecting visible sidestream smoke: “‘The invention relates to a cigarette paper having... low total filler content, 20% by weight of the paper or less, a proportion of the filler being a filler capable of effecting visible sidestream smoke reduction. The basis weight of the paper is about 30 g m.sup.-2 or more. Smoking articles made with such papers provide a synergistic sidestream smoke component reduction when compared with control cigarettes. Papers according to the invention with the addition of various burn additives are also described....” (Case & Stephenson, 2002)</p> <p>Non-combustible wrapper: “‘The invention relates to a smoking article having a high proportion of non-combustible, inorganic material and a relatively low level of visible sidestream. The smoking article includes a substantially non-combustible, wrapper which extends along the full length of the smoking material rod and enwraps a combustible fuel source and aerosol generator, both of which extend substantially along the length of the smoking material rod....” (Beven et al., 2003)</p> <p>Addition of calcium carbonate: “‘A wrapper paper for a smoking article, which permits decreasing an amount of visible sidestream smoke of tobacco, contains at least 30 g/m2 of calcium carbonate and at least 3% by mass of a burn adjusting agent.” (Ishikawa, 2004)</p> <p>Oxygen storage and donor metal oxide oxidation catalyst and an essentially non-combustible particulate adjunct: “‘A low sidestream smoke cigarette comprises a conventional tobacco rod, and a combustible treatment paper having a sidestream smoke treatment composition. The treatment composition comprises in combination, an oxygen storage and donor metal oxide oxidation catalyst and an essentially non-combustible particulate adjunct for said catalyst. Improvements are made in the treatment composition and/or the addition of metal oxides or carbonates thereto to improve ash characteristics.” (Snaidr, Becker, & Chapman, 2003)</p>

reduction in morbidity or mortality among individual tobacco users is reasonably likely. The U.S. Surgeon General has stated that there is insufficient evidence that strategies to modify tobacco products to lower the emissions of specific toxicants in tobacco smoke reduce the risk of the major adverse health outcomes caused by cigarette smoke (USDHHS, 2010).

Cigarette manufacturers could incorporate technologies or additives that alter the qualities of cigarette smoke into conventional brands but may not explicitly communicate the fact. This underscores the need for disclosure to the FDA by manufacturers and further research to understand factors that influence consumer perceptions of SHS and SHS exposure risks. The purpose and mechanism of action of technological innovations is not always apparent based upon a listing of product additives. Therefore, in tandem with the reporting of product design information, there is a need for disclosure of the purpose(s) of any innovation to the FDA. For example, compounds which mask SHS odor perceptions, such as vanillin, may also provide non-characterizing flavor qualities that increase product appeal. Such cigarette additives should be reported for the full range of sensory effects.

Internationally, Articles 9 and 10 of the World Health Organization's Framework Convention on Tobacco Control (regulation of the contents of tobacco products and of tobacco

product disclosures) provide a basis for tobacco product design regulation for more than 170 countries (World Health Organization, 2003), including a commitment to regulate products that mask SHS. Other countries may wish to require the tobacco industry to report the use of additives or technologies whose purpose is to minimize or mask cigarette smoke.

Technologies and additives that reduce or mask SHS may contribute to enhanced social acceptability of cigarettes and could undermine progress in denormalizing public smoking. Additional research is needed to establish whether cigarette design alterations influence sensory and risk perceptions of smokers and non-smokers and estimate the likely influence on product use and social acceptance. Surveillance strategies should determine whether brands that incorporate SHS masking or minimizing technologies are marketed to a specific populations and whether the use of these technologies influence attitudes and behaviors, including risk perception to cigarette use.

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None declared.

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