



State of Tobacco Industry in 2024

— GreyB's
Report





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We help companies solve their most pressing innovation challenges

Who could be your next competitor? What breakthrough tech will change your industry next? What are your competitors doing in their research labs?

And what should be your next step in your business and research strategy?

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Trends in Tobacco Industry

The tobacco industry has seen renewed competition through new entrants in the electronic cigarette & vaporizer products market. Hence, it is vital to keep track of innovations in tobacco industry to see where the industry is headed. Looking at various research activities, vision statements, forums, etc., we concluded following innovations trends will be in limelight in near future -

1. Age Validation/Verification Tech

2. Biometric Features

3. Ceramic Heating

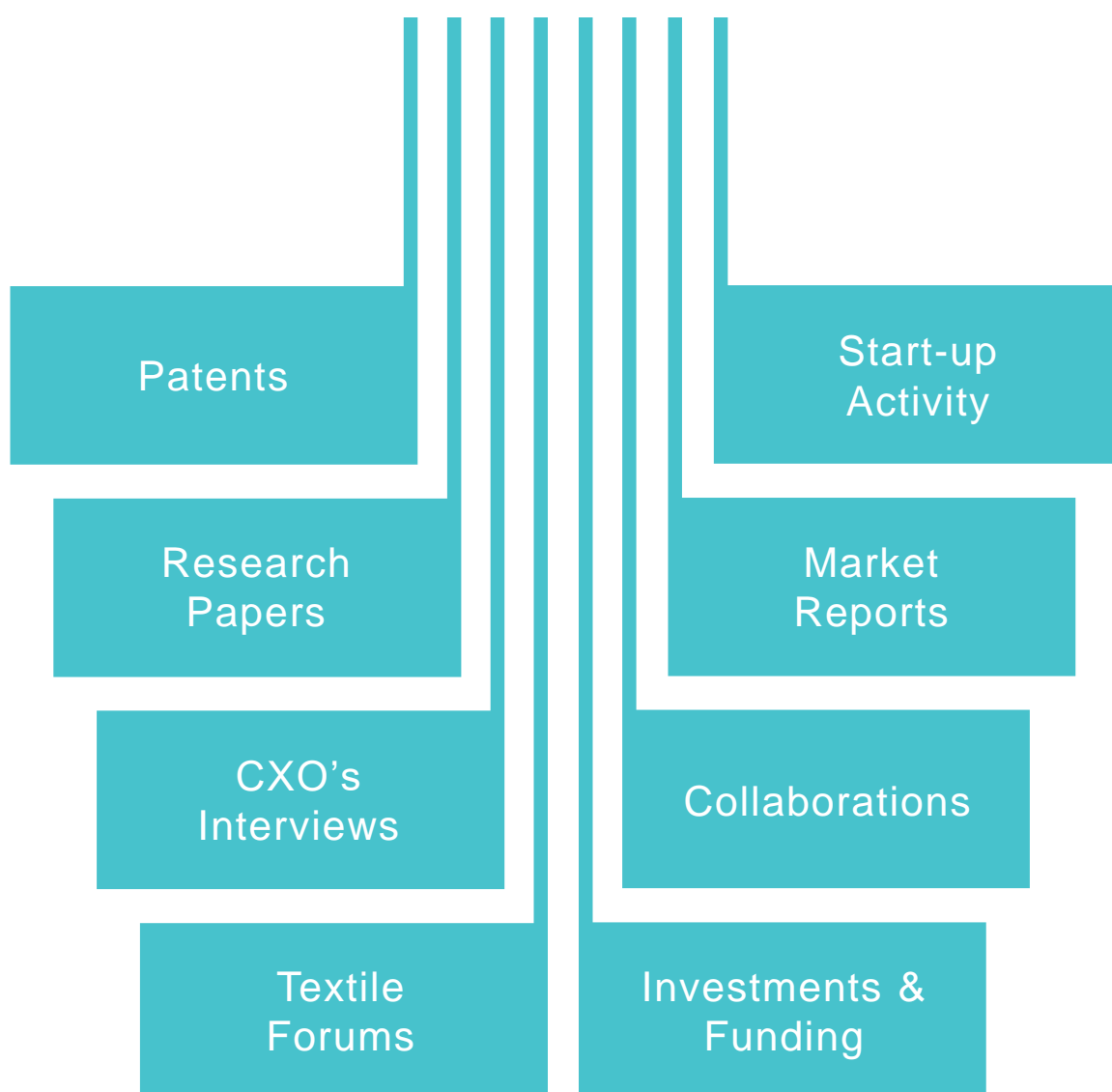
4. Smart Devices

5. Sustainable Products



Why we think these trends are going to be the big thing for 2024?

To spot out the themes that could become trends in the coming year, we explored various recent data sources and then analyzed them to highlight the themes which are commonly occurring in most of these sources. This provided us with a list of innovation trends which are targeted by entities in various areas (such as patents, research papers, vision statements, textile forums, etc.). And, these themes have a very high probability of becoming main-stream trends in new future. Below are the parameters we considered for figuring out these trends -



1. Age Validation/Verification Tech

Underage use of tobacco based products, both cigarettes and vaporizers, has always been at the forefront of the industry. Legislations and policies have been used to prohibit sales of tobacco products to minors, with the US federal law also being amended to raise the legal purchase age from 18 to 21 years.

When it comes to e-cigarette and vape manufacturers, we see an increasing interest in developing **age based verification technology** for products in their portfolio. The primary driving factor behind this push seems to be a potential strengthening of laws regarding sales to underage consumers, with the FDA already issuing warning letters to retailers engaged in sales of non-tobacco nicotine products to underage users.

Driving Factor

The driving force propelling age validation technology seems to be stemming from multiple fronts such as:

- **media coverage** on underage consumption
- work of **regulatory bodies** such as the FDA on non-tobacco nicotine products
- **legislation amendments** setting forth requirements for verifying age and identity for online sales

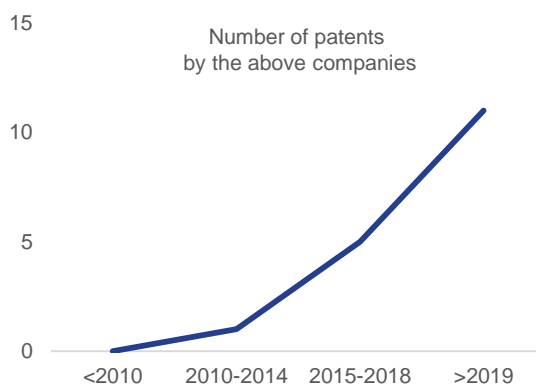
Even after raising the legal purchase age, around **34% of high school students** (5.22 million) and **11% of middle school students** (1.34 million) reported ever using a tobacco product in 2021. ([Source](#)).

Student using tobacco products



To cater this, in FY 2021, Centers for Disease Control and Prevention (CDC) spent over **\$96 million for tobacco control programs** ([Source](#)).

Further, the top tobacco companies in the world like British American Tobacco (BAT), Japan Tobacco International (JTI), Philip Morris International (PMI), Korea Tobacco & Ginseng Corporation (KT&G), etc. are researching on age validation technology to tackle the underage consumption of tobacco.



Latest Developments

Nicoventures' third party age validation technology

Research from Tobacco giant BAT's subsidiary Nicoventures seems to indicate an interest on age validation technology.



The research focuses on an aerosol delivery security system where the aerosol device is unlocked for use after age verification by a third party age verification service provider. The company has filed multiple patents around this technology. ([Source 1](#), [Source 2](#), [Source 3](#)).

These patents also mention that the possible age verification service provider can be Jumio™ (an online mobile payments and identity verification company).



Further, BAT's 2020 FY 'Results Script' hinted towards "piloting new launches incorporating age verification technology in key markets" ([Source](#)).

All these activities indicate that the company may launch a product soon

Reynolds' two step age validation technology

Reynolds American (subsidiary of BAT) also seems to be researching in the field of age validation technology.



Reynolds' approach seems somewhat different compared to that of Nicoventures, in that their research suggests a two step process: age verification + authentication. This two step process enables the company to re-verify age based on some predefined conditions like replacement of a cartridge. Such a system seems configured to prevent exploitation by a user unlocking devices for underage users ([Source](#)).

Reynolds' two step age validation technology

Another approach by RAI suggests use of 'Security Tags'. These tags (could also be applied to cartridges) are suggested to act as locks for the device, and upon proper verification/authentication, can be removed. In case attempts are made to remove the tags, the device could potentially be disabled. One of the methods of performing the authentication is by visiting a website and inputting a serial code associated with the tag. Upon successful verification, the tag can receive an indication and be removed ([Source](#)).

Philip Morris is using biosensor in e-cig for age validation

Philip Morris has also been researching on the age validation problem. Research by the company on 'biometric information', clearly indicates the entity's interests in addressing this problem.



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The research talks about an aerosol system with a single or multiple biosensor configuration, which are used for collecting biometric information from users. The collected information is then analysed to validate a user's age. One of the methods of analysis is said to be comparison of heart rate signals with some reference patterns. Other types of biometric information include arterial stiffness, blood pressure etc. can enable judgment of a user's age ([Source](#)).

Interestingly, PMI's 'INTEGRATED REPORT 2021' indicated an interest on "Enhanced electronic age-verification technology". The report talks about proprietary age validation technology built into the VEEV series of products. The technology requires consumers "to prove their age with reliable online data, to unlock, and thereby activate the device prior to first use. If the device was not linked to an age-verified consumer profile, the device would then remain blocked and unusable" ([Source](#)).

The report additionally touts the age validation technology as a "novel advance" which requires partnerships and collaborations between IT service providers and owners of software applications. One such provider seems to be TruAge, which has listed Altria as one of the sponsors on its website ([Source](#)).



The company already launched pilot programs for technology testing and evaluation in 2020 (New Zealand) and 2021 (France). The company also plans to launch further pilots.

Altria is also using third party for age verification technique

Similar to Nicoventures, Altria also seems to be researching on age verification technology. The research talks about an identity verification server which may be connected to a third party identity verification service.



These verification server will ask some questions to the user for age verification. Interestingly, the company is also seeking patent protection for their research. ([Source](#)).

How is the ecosystem of entities researching on age validation technology?

Tobacco companies



Startups

Shenzhen Baimei Tech Co Ltd

Ningbo High Tech Zone Ladder Science Co Ltd

Non-Tobacco Companies



Academia

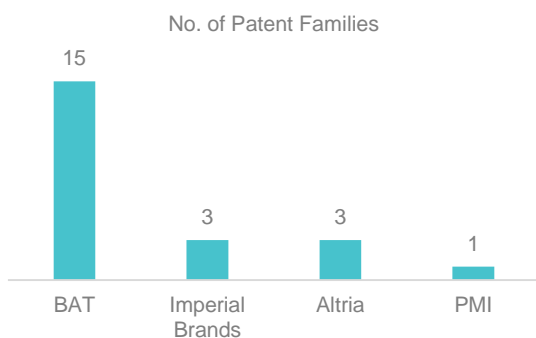
Which entities have collaborated for age validation technology?



Do You Know?

British American Tobacco is researching 5 times more than its closest competitor for age validation technology

Looking at the patent published in the space of age validation technology in the last 2 years, we noticed that British American Tobacco is at top. Through its subsidiaries like RAI Strategic, Nicoventures, and RJ Reynolds it has made 15 innovations for age validation technology.



Its closest competitor from research perspective is Imperial Brands and Altria who have filed merely 3 patents each. This shows that BAT has researched 5 times more than its competitors in this space.

Cross-industry collaboration the answer to harnessing Age Validation tech

The underlying IT needed for delivering age validation solutions seems to be beyond the functional focus/boundary of e-cigarette and vape manufacturers. We see cross-industry

solutions as the way to deliver Age Validation tech. Tobacco sector is witnessing collaborations with non-tobacco players **Altria and Reynolds with TruAge, BAT with Jumio and Hauni with authenteq**, with all the non-tobacco players seemingly possessing the IT to support the age verification process.

Some Chinese players in the e-cigarette space also seem to be researching actively in the age validation space, indicating a global interest in the field

Research by **Ningbo High Tech suggests application of facial features** for validating a user's age. The user's image is captured/acquired using a miniature camera, facial features extracted, and using facial age estimation techniques (AI powered facial recognition chip), an age value is obtained. If it is determined that the user is a teenager/underage, the device use can be prohibited ([Source](#)).

Research by **Shenzen Baimei Tech also seems to indicate an interest in facial detection technology**. The method broadly seems to be similar, use of an onboard camera to capture images, followed by subsequent application of AI based user age evaluation using a comparison of facial features ([Source](#)).

2. Biometrics

Biometric based authentication has become ubiquitous. Digital security of items, from personal devices such as mobile phones, smart watches, laptops and workstations to even security of physical items through use of smart locks has proliferated and advanced the applicability and suitability of biometric (fingerprints, iris scanners, facial authentication etc.) based systems in a consumer's day-to-day life.

As electronic cigarettes and vapes increase in popularity and the underlying biometric tech develops, one could envision the tech to find its way into these devices.

Driving Factor

The top driving factor for biometric technology is its **capability to prevent underage use of tobacco products** by limiting access to verified users.

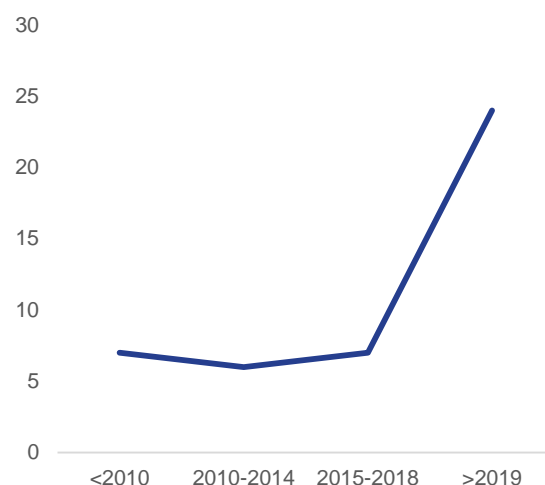
Also, **activities of the top companies** have also been a major driving factor for implementation of biometrics in tobacco products. This is also evidenced by research carried out by **Phillip Morris** ([Source](#)) and research from **Georgia State University** ([Source](#)).

Vapor Corp (later renamed to Healthier Choices Management Corp.) unveiled an electronic cigarette prototype, incorporating fingerprint based device locking and unlocking, all the way back at CES 2014 ([Source](#)). The main driving factor behind

implementing such a feature was device security. A fingerprint based activation would prohibit use of the device by unintended users.

The following graph shows patent filed by top tobacco companies in the space of biometric authentication.

Number of patents by top companies



Further, interest in this technology also stems from the work being done by the FDA, with TPL reviews of PMTAs suggesting device access restrictions in the form of "technologies that require adult user identification by fingerprint or other biometric parameters in order to unlock and use a tobacco product" ([Source](#)).

Latest Developments

Although biometrics play a role in enabling Age Validation technology, research by companies operating in the space suggest other applications as well.



Research by South Korea's KT&G suggests use of biometric information sourced from the image of a consumer's pupil. This image is then used to compute the emotional state of a user through which, use of different types of cartridges associated with an aerosol device can be recommended, thereby improving consumer satisfaction. Impacts including minimizing the negative emotional state of users (e.g. cartridges containing vitamin D) or even enhancing a positive emotional state (e.g. cartridge containing menthol) ([Source](#)).

Further research by the company also suggests training of biometric based user authentication models. Such training might prove in handy in case of issues associated with biometric sensors such as contamination or a change in user biometrics. Suitable biometric data fit for this training includes, but is not limited to, iris data and finger print data ([Source](#)).

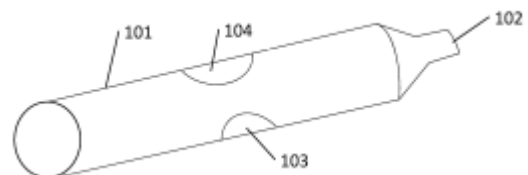
Hence, the research by KT&G seems to imply an interest in incorporating biometric technology.



Japan Tobacco (JT/JTI) has also been active in carrying out research pertinent to biometric technology. They have researched upon multiple technologies.

Blood pressure, heart rate, and oxygen saturation info to limit the use of aerosol devices

Research by JT suggests use of **biological information like "blood pressure, heart rate, blood oxygen concentration, and oxygen saturation"**, which could possibly be used to limit the functioning of aerosol devices. Unlike fingerprint or touch based systems, JT's approach seems to **involve use of reflected waves (like natural light, infrared and radio waves)**, which can be captured by sensors such as a camera, making the process contactless. Research further suggests monitoring biometric information at two points in time, such as before and after an inhalation of a puff, and if the conditions exceed certain predetermined thresholds, like an increase in blood pressure, device operation could potentially be inhibited ([Source](#)).

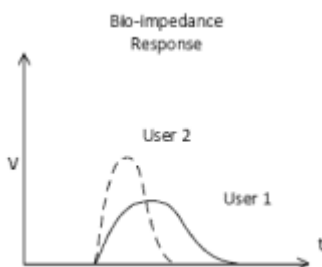


JT's research to use biometric data to develop a stress state information

Research by the company suggests devices equipped with **sensors for measuring biometric data**. This **biometric data can be used to develop a stress state information**, which in a way seems similar to the research carried out by KT&G. The types of biological data can be measured to generate the **stress information include pulse, sweat, saliva, heartbeat etc.** However, unlike the KT&G system which suggests the use of different types of cartridges, the research by JT suggests generation of recommendations such as messages (take a break, location of rest facilities etc.), using the biometric data ([Source](#)).

Pulse based techniques for authentication

Research by Japan Tobacco also indicates an interest in **pulse based techniques, citing deficiencies of retinal or fingerprint based authentication** in terms of volume and simplicity requirements.



This system works by taking two biometric measurements by applying a voltage followed

by measurement of a bioimpedance response (which is unique for each user). These measurements are compared to user specific reference data to permit authentication ([Source](#)).

Tooth-print based biometric systems

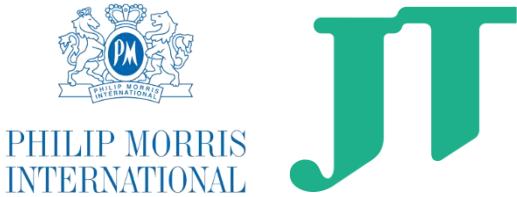
More research by JT suggests use of **tooth-print based biometric systems**. The application is again explained in terms of preventing unauthorized use of devices. The tooth-prints could be captured through a pressure profile, spectral analysis via radiation or the data could even be in the form of a “specific resonance frequency”. Such a configuration is also suggested to readily distinguish between the tooth profile of a child from an adult consumer ([Source](#)).

Fingerprint technology, for aerosol devices

Another research by Japan Tobacco also seems to indicate an interest in **the use of contact-based, fingerprint technology**, for aerosol devices. Research by company indicates placing a fingerprint sensor and device activation switches opposite to each other, such that it is convenient for a user to both activate the device and verify their identity (use of device restricted to authorized persons) ([Source](#)).

Which entities are working on Biometrics?

Tobacco companies



Startups

Vapor Corp



Non-Tobacco Companies



Academia



Do You Know?

Japan Tobacco has conducted research surrounding security of biometric data



Since biometric data is personal, and private, data breaches can pose serious consequences. Research by Japan Tobacco suggests generation of encryption keys in order to perform biometric authentication, such that an attacker can only obtain encrypted data in case of remote attacks ([Source](#)). Further research by the company indicates going a step above simple encryption, using cryptographic hashing. This is crucial since physical theft of devices which secure data via standard encryption are vulnerable ([Source](#)).

Research from JT on the pulse based bioimpedance authentication cites research by academia titled: "[Pulse-Response: Exploring Human Body Impedance for Biometric Recognition](#)" and "[Zensei: Embedded, Multi-electrode Bioimpedance Sensing for Implicit, Ubiquitous User Recognition](#)".

Non-tobacco companies have also conducted research regarding biometric systems in e-cigarettes and vapes



Research from China based Shenzhen Goodix Technology, a company which develops and sells fingerprint sensors, touch controller etc. for mobile phones and tablets, focuses on bio-tracing of consumable devices such as electronic cigarettes, for usage tracking, usage restriction etc. Suitable means include fingerprints, blood, heartbeat among others ([Source](#)).



Research from South Korea's CrucialTec, which again primarily works in the hardware technology sector, talks about biometric (fingerprint or iris) authentication driven vaporizer devices ([Source](#)).

3. Microporous Ceramics

The type/construction of the heating element of electronic cigarettes and vaporizers plays a crucial role in determining the device quality. In conventional heating arrangements, liquid from a reservoir is soaked by fibers such as cotton or polypropylene etc. and is eventually contacted with the heating element to be vaporized.

Although materials like cotton exhibit good wicking properties, they seem to demonstrate poor thermal stability and other issues such as poor contact with the heating element. Since the heating element plays a fundamental role in the vape experience, we notice an increasing interest in the use of ceramic based technology.

Driving Factor

The ceramic based heating element seems to offer a number of benefits such as –

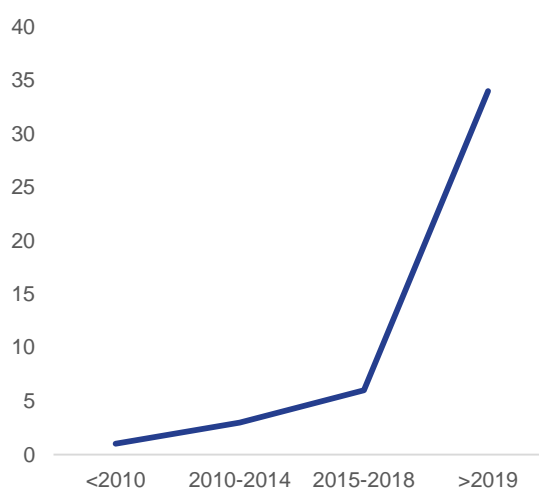
- an improved taste profile due to the ceramic being inert to the e-liquid
- increased longevity
- ease of cleaning
- minimizing the possibilities of a dry-hit
- good thermal conductivity

([Source 1](#), [Source 2](#)).

To this effect, a recent study was carried out by BAT to investigate the impact of microporous ceramic wick based systems on the vapour emissions. The study suggested a substantial decrease in the amounts of harmful and potentially harmful constituents (HPHCs) and smoke toxicants when compared with conventional cigarettes ([Source](#)).

Reports regarding research conducted by other companies such as FEELM, also seem to highlight benefits in terms of temperature control, even temperature distribution and reduction in the amounts of aldehydes and ketones produced. Another remedy in terms of the elimination of partial carbonation and reduction of “burnt taste” has also been highlighted ([Source](#)).

Number of patent publications by top companies



Latest Developments

When it comes to ceramic based heating technology, SMOORE's FEELM brand seems to be leading the innovation race. The brand "specializes in the development and manufacturing of high quality atomization devices" based on ceramic heating technology. A collaboration with R.J. Reynolds dating back to 2018 has also been highlighted ([Source](#)). Other partnerships include RELX ([Source](#)), NJOY ([Source](#)) and HEXA ([Source](#)) amongst others. The NJOY Ace became the first FDA authorized vape powered by FEELM's ceramic coil technology in April 2022.



As of 2021, FEELM has launched ceramic coil solutions for disposable vapes and the production capacity breached the 3 billion/year mark ([Source](#)). University-Industry collaborations with Oklahoma State University, Virginia Commonwealth University, South China Polytechnic University and a few others also seems to be a part of the company's research strategy ([Source](#)).

As per the company, the ceramic technology seems to offer numerous benefits over cotton coil based systems such as $<1\mu\text{m}$ aerosol particles for enhanced flavor characteristics, better temperature uniformity, reduction of burnt taste and better air tightness/reduction in leakage ([Source](#)).

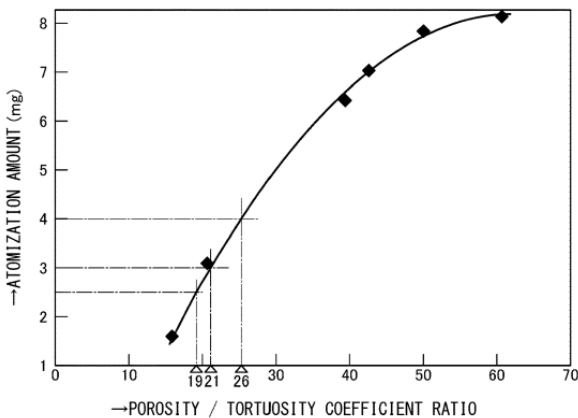
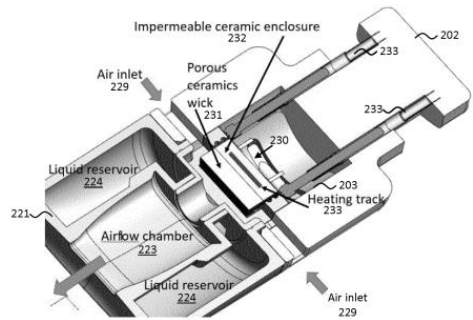
Further research by the company dives deep into the materials science behind the ceramic atomizer. Research suggests a porous body on which a heating element is disposed. This porous body is described to include a "porous ceramic layer doped with a hydroxyl group-containing matrix". Such a configuration enables hydrogen ions in nicotine, that has not been vaporized, to chemically react with the hydroxyl groups, reducing protonation degree (lower protonation of nicotine results in a higher user satisfaction), improving absorption of nicotine in the lung ([Source](#)).

Other research by the company also indicates interest in developing atomization devices constituting a ceramic heating element and a metal film. Per the company, the ceramic-metal film based system provides a more comfortable user experience. Due to different expansion coefficients of the metal film and the ceramic material, such a setup exhibits poor bonding. To overcome this, the film is suggested to include stainless steel, glass powder and a control component (alumina, zirconia and silica) ([Source](#)).

RELX

Although RELX and FEELM/SMOORE have been collaborating for a while to bring the porous ceramic heating technology to the market, research indicates that RELX is also working on developing solutions. Research by the company focuses on the process of obtaining the microporous ceramic structure, such as through use of pore forming agents like graphite, carbon powder or wood chips, to obtain high porosity, controllable pre size and favourable mechanical properties ([Source](#)). Research by the company also indicates the optimal permeation rates for the porous ceramic matrix to be in the order of 0.8-4 mg/s.bar.mm², to ensure optimal inhalation experience ([Source](#)).

Research from PMI also indicates interest in devices which make use of capillary action based ceramic elements. In this setup, the ceramic material is in communication with the e-liquid on one side and in thermal communication with a heater on the opposite end ([Source](#)).



Research from Nerudia, an Imperial Brands subsidiary, also seems to indicate an interest in the use of porous ceramics as a material for forming the wick ([Source](#)).



the market, also indicates an interest in use of microporous ceramic heating technology. Research by JT indicates use of porous ceramic materials with porosity to tortuosity to be 21 or more. High porosity and low bend ensures efficient atomization performance ([Source](#)).

Which entities are working on Microporous Ceramics?

Tobacco companies



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Startups



Non-Tobacco Companies



Do You Know?

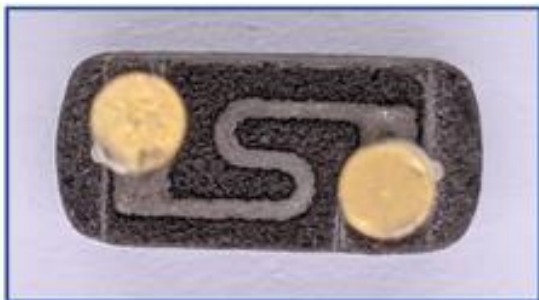
BAT and Reynolds also seem to be researching on the use of porous ceramics



BAT and its subsidiary RAI, also seem interested in the application of porous ceramic materials. Research by BAT suggests the possibility of forming aerosol devices wicks from porous ceramics ([Source 1](#), [Source 2](#)).

Research by RAI goes a bit further back in time and makes reference to use of a porous monolith as a liquid transport element, which includes one porous ceramic component ([Source](#)).

The application of ceramic wick technology is also evidenced by Reynold's VUSE range of products ([Source 1](#), [Source 2](#)).



There seems to be significant research interest in the ceramic heating technology stemming from China

ZOVOO



Research from China showcases strong interest in the microporous ceramic technology. Companies like Zovoo already seem to have launched ceramic core based products like the Zovoo Gene Tree Special Edition. The company touts use of industry first, patented, "powder free" ceramic core technology, which according to the company, helps maintain puff purity ([Source](#)). Shenzhen based Eleaf is also researching on ceramic wicking system based heads in light of its temperature resistance and increased lifespan ([Source](#)).



Other players like HQD Tech ([Source](#)), SMISS Tech ([Source](#)) and CNHK ([Source](#)) amongst others, all seem to be actively researching on the technology.

4. Sustainable Products

Prioritizing sustainability has become a norm in all kinds of organizations operating in the global market today and the tobacco industry is no such exception. All of the major players: Philip Morris, Japan Tobacco, British American Tobacco and Imperial Brands have published reports highlighting their ambitions in making their value chain more sustainable ([Source 1](#), [Source 2](#), [Source 3](#), [Source 4](#)).

Driving Factor

With over 5 trillion unit sales of retail cigarettes annually, it is no wonder that companies are looking for alternatives to make their operations more environmentally friendly and reduce the environmental impact of products in their portfolio. A recent report by the WHO brings attention to the environmental impact of the industry and the numbers speak for themselves: “600 million trees, 200 000 hectares of land, 22 billion tonnes of water and 84 million tonnes of CO₂” ([Source](#)).

Increasing cigarette butt waste

Recent research by academia also indicates **interest in introducing the “Circular Economy” concept to tackle the environmental pollution associated with cigarette butts waste**, the most frequently littered item in the world ([Source](#)).

Government Regulations

We also see **regulation and policies** to be one of the potential driving factors pushing companies to rethink their product design. The European Union’s directive on tackling the single use plastic problem also takes aim at the pollution caused by cigarette butts. Talks also include mentions of other cigarette and e-cigarette waste which, if not disposed properly, might end up polluting land, air and water, with toxic substances, heavy metals etc. ([Source](#)).

Latest Developments

Philip Morris



PHILIP MORRIS INTERNATIONAL

Philip Morris clearly emphasizes work being done to make their products more sustainable. The company is actively working on the post-consumer waste problem and is implementing eco-design and circularity in their products ([Source](#)).

Philip Morris Mexico has partnered with a local start-up, Ecofilter, which aims to reduce cigarette butt littering through a “biotechnological treatment that regenerates cellulose acetate into cellulose pulp” ([Source](#)). Research by the start-up led to a recent Mexican patent publication which sheds light on the use of solvents and fungi enzymes based process to reuse/reprocess cigarette butts for raw material use in manufacturing of paints, coatings, paper etc. ([Source](#)).

The partnership has led to establishing Ecofilter’s factory in Guadalajara, Mexico and can process 300 tons of cellulose annually ([Source](#)).

Primary research by PMI also indicates an interest in developing biodegradable filters. Recent research by the company shows use of fibrous paper-like material which comprises a combination of hydrophobic and hydrophilic fibers.

“Further, the fibrous paper material has a biodegradability in aqueous medium as tested in accordance with ISO 14851 (2005) of at least 90 percent of the maximum degradation of a cellulose reference item within 56 days of testing” ([Source](#)).

Japan Tobacco



Japan Tobacco also emphasizes on tackling the problem of waste, suggesting it to be “important to the future of our business”. Research by the company indicates interest in developing filters with high degradability. One of the approaches investigated by the Japan Tobacco mentions use of natural fibers as opposed to cellulose acetate. The use of a filter based on natural fibers (pulp, cotton, hemp etc.) clubbed with the tobacco segment containing trisaccharide and tripeptide in a ratio of 12-60, can maintain flavor quality and act as a substitute for cellulose acetate ([Source](#)).

The company also seems to have conducted research surrounding problems materialized through use of natural fibers, like the ventilation resistance, which can be remedied through “compressing the nonwoven fabric containing the natural fiber” ([Source](#)).

KT&G



Research by South Korea's KT&G Group also sheds light on the biodegradability of cigarette filters. The company aims to develop filters which are both biodegradable and maintain the smoking characteristics. Work done by KT&G suggests use of the biodegradable filter to contain seeds such as vegetable seed belonging to the Brassicaceae family, with a 0.5-2 mm diameter. When such cigarettes are disposed into soil as a butt, the seeds will germinate, thereby disrupting the structure of the cellulose acetate and is also easily hydrolyzed ([Source](#)).



The company has also conducted research on alternative approaches to enhance the biodegradability of the filter. One such technique involves use of plasticizers which can enhance the biodegradability of the product, such as those composed of natural material extracted from a clove plant, as a substitute to artificial plasticizers such as triacetin, which are conventionally employed. Research also indicates other benefits to the

product such as the introduction of clove flavor ([Source](#)).

Talking beyond the filter material, KT&G has also researched on enhancing the biodegradability of the cigarette paper/tipping paper. As per the company, the biodegradable paper may include biodegradable polymers like, polylactic acid (PLA) or polybutylene adipate terephthalate (PBAT) or a combination. Research indicated the biodegradable cigarette paper to be completely decomposed after 200 days in composting conditions of a temperature of 58°C and humidity of 70 % ([Source](#)).

British American Tobacco



British American Tobacco is also following PMI's footsteps and has partnered with a start-up, Chile based IMEKO, to realize waste valorization of cellulose acetate present in cigarette butts ([Source](#)).

Which entities are working on Sustainable Products?

Tobacco companies



PHILIP MORRIS
INTERNATIONAL



Startups



Fanpinsi Shenzhen Technology
Co Ltd

China Tobacco Anhui Industrial Corp

Non-Tobacco Companies



delfort



IMEKO

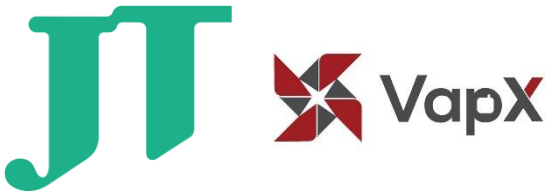


Academia



Do You Know?

Beyond tackling the cigarette butts biodegradability problem, companies are also researching sustainability of electronic devices



Japan Tobacco has conducted research focusing on biodegradable cartridges for vapour based systems. Research voices concerns about waste generated through disposable and single use components such as capsules and containers. Per JT, the biodegradable material could be paper, cotton, natural fibres, and/or recycled biomaterials ([Source](#)).

Similarly, research by China based VapX group focuses on minimizing the problem of waste by circumventing the problem of discarding the atomizer by providing a modular/detachable configuration, making it recyclable ([Source 1](#), [Source 2](#)).

China Tobacco Anhui partnered with University of Science and Technology of China for research on biodegradability of particle-type heated cigarettes

The research mentions that where conventional products employed a plastic firmware material for encapsulating tobacco particles. They try to circumvent the problem by using a biodegradable firmware material. Further, use of PBAT, PBS, PVA and PLA, all bio-based polymer materials (which have excellent biocompatibility and degradability), as the base material has been suggested ([Source](#)).

Non-Tobacco players are also researching on sustainable solutions

Companies like delfort and Bio-On, are researching on biodegradable filter materials. Research by Bio-On specifically suggests using polyhydroxyalkanoate (PHA) (a highly biodegradable polymer) as the binding material for cellulose acetate fibres as opposed to triacetin ([Source 1](#), [Source 2](#)). As per the company, the filter can also reduce upto 60% of the harmful ROS ([Source](#)).

5. Smart Devices

The tobacco industry is increasingly incorporating technological advancements into their products, driven by the availability of multi-functional tech-based products (such as smart watches) and the ability of products to communicate and exchange information with each other (Internet of Things). This trend is fueled by the widespread adoption of advanced technology across various industries.

Driving Factor

Although this report has previously covered features/functionality like incorporation of age validation technology or biometric based features in e-cigarettes and vapes, we see interest in introducing features which offer additional functionality and capability embedded within the product.

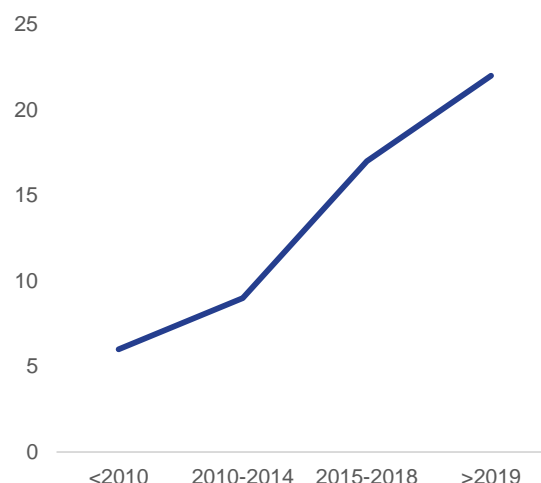
Academic Researches

Research by academia **showcases an interest in ‘Smart Electronic Cigarettes’**, integrated with aerosol sensors. Through monitoring aerosol parameters, a user could be warned in case hazardous aerosol is detected. In essence, smart devices or technology could help minimize risks associated with product use ([Source](#)).

Age restricted product regulations

In addition to minimizing product risk, the use of smart products could help companies deliver on potential age restricted product regulations. Juul’s C1 product launched with a companion mobile app which allowed users to “lock the device so that no one can use it”. The company additionally hinted at the possibility of adding geographical restrictions such as usage around schools in the future ([Source](#)). Therefore, smart capabilities certainly seem like a possible means to comply with regulations.

Number of patent publications by top assignees



Latest Developments

Japan Tobacco

Japan Tobacco seems to have conducted extensive research when it comes to the field of 'Smart Devices'. Research by the company indicates an interest in use of NFC and RFID technology amongst others.



The research on NFC technology suggests aerosol devices to be equipped with an NFC antenna for bi-directional communication with external devices. The research suggests that using NFC over other commonly used protocols such as Bluetooth and Wi-Fi is to avoid the need of a device pairing process, which can be "laborious". NFC also consumes relatively lower power compared to the other protocols discussed above. Possible data exchanges with the external device include: authentication data, status data, diagnostics data, programming data etc. ([Source](#)).

Another use of the NFC technology researched by Japan Tobacco includes the use of "NFC tags" for device operation. The devices make use of said tags in pairs, with one in the device inhaler body and another on removable cartridges. The use of such a setup might enable controlling compatibility and also act as security trigger. However, use of metallic components which influence communication hinder the process. This problem is being solved by modifying the

device construction and components/materials such as through "ferrous plugs" which have lesser impact on NFC communication ([Source](#)). The company's interests in NFC technology are also evidenced by research on the hardware side of things, focusing on flexible printed circuit boards (PCB) supporting the NFC antenna ([Source](#)).

Another research by Japan Tobacco also indicates an interest in optical sensors, such as infrared (IR) sensors, which would enable communication between a vape device and a smartphone. Instead of using the device interfaces for programming parameters such as temperature, flow etc., they are using cheap and hard to intercept optical communications, through a smartphone ([Source](#)).

JT has also addressed the possibility of health monitoring through a smart device network. One of the research by JT indicates utilizing device use information and a user health information (such as through wearable devices like a smart watch) to determine changes in health due to use of aerosol devices ([Source](#)).

British American Tobacco

Research from British American Tobacco (Nicoventures) also seems to indicate an interest in smart device functionality.



Recent research by the company indicates interest in aerosol devices comprising a motion sensor and also an Artificial Intelligence (AI) model. Research suggests the AI model to define “an alphabet of multiple characters, each character corresponding to a movement pattern”. The AI model receives data from the motion sensor and identifies a particular character. These symbols/characters could then be used to control device functionality like device activation, device lock etc. ([Source](#)).

Other research by the company also indicates an interest in RFID technology. The research particularly describes consumable product packages to include RFID tags, which can be interrogated by an RFID reader to fetch information about the product package. Such a setup minimizes manufacturing costs by reducing the number of tags to one, instead of placing one on every consumable ([Source](#)).

The company has also researched on “user-profiles” for aerosol devices. As per the research, aerosol devices can include a “user-profile module”, which can store a multitude of user-profiles. These user-profiles are configured to retain user preferences which can control the functioning of the aerosol device. Such a setup allows a user to transfer preferences and may enable a user to

configure a new or shared aerosol device based on their predefined preferences ([Source](#)).

In terms of other “Smart” functionality, the Vuse line of products by the company already comes with a companion app for both Android and iOS devices. Using the app enables users to lock the device, locate the device in case it is misplaced, “Cloud Control” allowing users to control the vapor production, the app also sends battery recharge reminders as well as it keep tabs on the usage of the device ([Source](#)).



Reynolds American



Reynolds American is also working in the smart devices space. Like Nicoventures, they have also worked on “Artificial Intelligence” enabled aerosol systems. The research talks about development of machine learning models using machine learning algorithms. These models are configured to predict a “target variable” (such as measure of user health) and control functionality of the device based on said variable ([Source](#)).

Like BAT, a couple of other companies also suggest use of Artificial Intelligence/Machine Learning.



Research from Nerudia, an Imperial Brands subsidiary, talks about aerosol devices comprising a machine learning model. The model receives device usage data and uses it to predict future usage. This could be helpful in determining important events such as battery depletion, consumable depletion and device activation. The company suggests that the model does not need to be trained or executed on the device itself but could be trained on separate and powerful machinery, and may also include usage data for multiple devices.



Research by Juul indicates use of an ML model which predicts an amount of vapor production. Per the company, the model may provide usage control to the user ([Source](#)).

Other companies like Relx talk about use of NFC for bi-directional communication with external devices, including real time data transmission. Shenzhen Smoore talks about using Bluetooth technology for prohibiting use of aerosol devices in restricted areas (via scanning broadcast messages through pre-placed Bluetooth tags)([Source 1](#), [Source 2](#)).

Research by other non-major tobacco players like France based Enovap, also highlights use of Artificial Intelligence for providing personalized support in reducing nicotine intake. The device analyzes consumption habits for 30 days after which it smoothly reduces nicotine over a period of days ([Source](#)). Further details can be accessed from the company’s research [here](#).



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