A Study of Talc-Containing Cosmetics and Their Potential Asbestos Contamination

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A Study of Talc-Containing Cosmetics and Their Potential Asbestos Contamination

By

Jessica N. Donahue

An Honors Thesis Submitted in Partial Fulfillment of the Requirements for Graduation from the Western Oregon University Honors Program

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Abstract
Talc, a versatile mineral found in many products, is a common ingredient found in cosmetics. This metamorphic mineral is found in the fault lines along with the minerals that make up asbestos. Given their close proximity, it is possible that the talc used in cosmetic products can be contaminated with asbestos. This study tested six cosmetic samples from various price points, which include the brand names Covergirl, L.A. Colors, Wet n Wild, Kat Von D, Nars, and Urban Decay. An FEI Phenom Desktop Scanning Electron Microscope was used to determine that three of the six talc-containing products have the potential of being contaminated with asbestos. The outcome of this study brings into question the purification methods as well as the regulations regarding talc in cosmetics.
Acknowledgments

This project would not have been possible without the assistance of the Electronics Department at Chemeketa Community College. Chuck Sekafetz allowed use of one of Chemeketa’s Scanning Electron Microscopes, free of charge, to complete this project. I would like to thank him as well as Moses Navarro for their help in learning how to use the instrument and their confidence in my work.

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I am grateful for Dr. Gavin Keulks, my honors program director, for teaching me how to control my inner perfectionist. I have always found writing frustrating because I could never get past not getting a decent draft the first time around. Thank you for teaching me that sometimes done is better than perfect.

Also, I have a massive amount of gratitude for my family, my friends, and my professors for putting up with my endless complaints about my thesis. Through it all, they were there pushing me toward my goals and supporting me 100%. I could not have done this without their advice, endless pep talks, and words of reassurance.
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**Introduction**

Although most people associate cosmetics with women, cosmetics are utilized by all people. Everyday items such as dandruff shampoo, toothpaste, and sunscreen are considered cosmetics. Cosmetics are defined in many different ways, however, many of them contain a common theme. Lopez-Galindo et al. define a cosmetic product as a substance intended to be placed in contact with the outside of the human body with the purpose of cleansing, changing appearance or smell, in addition to protecting and maintaining it.\(^1\) The way that Milstein et al. defines cosmetics is similar to the definition provided by Lopez-Galindo et al. Milstein et al. explains that cosmetics are employed to enhance personal appeal, camouflage flaws, and alter or improve upon nature by decorating the body. However, they are regarded as a standard of personal hygiene and health rather than a frivolous item.\(^2\) These products are not only described as a change in appearance or hygiene, they are also described by their marketing features. According to Milstein et al., cosmetics are consumer products that are marketed worldwide, and their purposes and functions are universal to people of all cultures.\(^2\) Since cosmetic products are marketed toward people universally, their use and regulation are significant to all consumers of these products.

Cosmetics have been utilized from before antiquity to modern times. These products were used to decorate the body during rituals of mating and hunting as depicted in cave paintings that are over 30,000 years old.\(^2\) While the products used in these rituals are not similar to the products that we see today, they still follow the definition of cosmetics since it was applied to the skin to change its appearance. Ancient Egyptians
were known for their common use of eye and face paints as well as body oils and ointments.\textsuperscript{2} One of the products that they used is called kohl. Kohl is a cosmetic product traditionally worn around the eye as eye makeup. It is used by women, men, children and babies in Asia, the Middle East, and most areas of Africa.\textsuperscript{3} Kohl was used for a variety of reasons in these regions. It was worn for tradition, beautification, and they thought that kohl was medically beneficial for the eyes.\textsuperscript{3} It was later found that the kohls used in these areas could be a cause of lead poisoning. A study done by Parry and Eaton from the University of Pittsburgh found that out of seventy-two samples of kohl purchased from many different parts of the world, nine of them contained less than 0.6\% lead by weight, seven contained more than 50\% lead by weight, and the rest ranged from 3.31 to 37.3\% lead by weight.\textsuperscript{3} The amount of lead found in these products is capable of causing major harm to the human body. In Tudor England in the 1500s, many of the commoners would use cosmetics to make themselves look more similar to the Queen of England. They did this by applying a toxic lead paint called ceruse to mimic the Queen’s pale complexion and rouging their cheeks with red ochre.\textsuperscript{2} However, during the 1500s, it was unknown to the general public that the use of lead had harmful repercussions. It has been discovered that some of the additives in cosmetic products today can have toxic effects on the human body. These additives include talc, which can contain asbestos if it has not been correctly purified to cosmetic grade standards. The purpose of this research project was to determine if cosmetic products such as powdered foundations, blushes, and eyeshadows contain trace amounts of asbestos.
Background Information

Regulations

In America, the U.S. Food and Drug Administration (FDA) aids in the regulation of cosmetics. The FDA is the organization responsible for the regulation and approval of various products to keep the general public in good health. The Federal Food Drug and Cosmetics Act (FD&C Act), enacted by Congress 1938, has been the guiding document for the FDA as they determine how to regulate cosmetic products. Under the FD&C Act, producers of cosmetic products are not required to have the FDA review or approve their products or the ingredients that go into them; nevertheless, the FDA monitors the products on the market for potential safety concerns but only takes action against a cosmetic if there is hard scientific evidence of safety concerns.

In 1973, the FDA proposed a regulation of analysis on the permissible amount of asbestos allowed in cosmetic-grade talcum powder. This proposal was not adopted because the method was too complicated and lengthy.

OSHA, or the Occupational Safety and Health Administration, is also a governing body responsible for the regulation of talc powder exposure in the United States and has instituted two regulations dealing with the permissible amount of asbestos found in high-grade talc powder. The first regulation, created in 1986, defined amphibole minerals as asbestos if they had a length to width ratio of 3:1 or greater. Since most fragments that are formed from these types of minerals have a ratio larger than 3:1, this regulation is not effective. The second regulation is known as the Hazard Communication Regulation and applies to every hazardous chemical that an individual can have contact with in the workplace. This regulation requires the labeling of substances that contain more than 1%
of a hazardous chemical and more than 0.1% of a carcinogenic chemical as hazardous. This regulation was difficult to enforce because technology capable of having a low enough limit of detection to successfully determine if a substance had 0.1% of a carcinogenic chemical was not available. Although OSHA has regulations in place for the asbestos content in high-grade talc powder, cosmetic-grade talc powder falls under FDA regulations. Under the current regulation guidelines, cosmetic-grade talc will remain unregulated in respect to its asbestos content before entering the marketplace.

In the European Union (EU), the European Commission (EC) is the agency responsible for the regulation of cosmetics. The European Commission prides itself on promoting innovation and competitiveness in the area of cosmetics while ensuring high levels of safety for the consumer. Since consumer safety is the European Commission’s number one priority, they keep the public well informed of potential safety hazards in cosmetics through a database called CosIng that contains a compilation of information including cosmetic ingredients, legal requirements, and restrictions pertaining to the ingredients. Like the FDA, the European Commission does not require the approval of cosmetic products before they are sold in stores; however, they do require all of the products marketed in the EU to be registered in the Cosmetic Products Notification Portal before they can be sold. The EU has stricter guidelines for what can go into cosmetics than the United States. According to Regulation (EC) No. 1223/2009, Talc is a substance which cosmetic products must not contain unless warning labels are added explaining its potential health hazards. This talc restriction relates to the potential adverse health effects caused by the use or inhalation of talc-containing products.
**Talc**

Talc, a hydrated magnesium silicate, has a chemical formula of $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$ and is a member of the phyllosilicate group. Many of the minerals in this group break off in flakes or sheets and have one prominent cleavage.\(^8\) The flaky nature of talc, shown in Figure 1, comes from its distinctive T-O-T structure. The T-O-T structure in talc is made up of $\text{SiO}_4$ tetrahedral layers, which form six member rings, and sandwich an octahedral layer made of magnesium ions and hydroxide groups (Figure 2).\(^8\) Oxygen atoms are shared between the layers, connecting them to form one sheet of talc. Even though each sheet of talc has a neutral charge, there are weak Van Der Waals forces that hold the sheets together, allowing them to break off easily.\(^8\) Its structure, as well as its chalky texture, give it the ability to take on many forms. The versatility of this mineral makes it a popular ingredient in cosmetics, paint, rubber, ceramics, and paper.\(^10\) Given its content in many common products, it is essential that talc is purified correctly in order to prevent long-term harm to the general public.

**Asbestos**

Asbestos is a group of naturally occurring serpentine and amphibole minerals. Before being listed as a carcinogen, asbestos was used for a variety of applications including, but not limited to, roofing, insulation, flooring, brake pads, and millboard. Its high tensile strength and thermal properties made asbestos a popular choice for these
purposes. Asbestos contains one serpentine mineral, chrysotile, and five amphibole minerals: actinolite, amosite, anthophyllite, crocidolite, and tremolite. Of these six minerals, chrysotile, anthophyllite, and tremolite are the three most commonly found minerals that contaminate talcum powder. Chrysotile originates from the metamorphic rock serpentine and has a chemical formula of Mg₃Si₂O₅(OH)₄. Since it is also considered a phyllosilicate mineral, its structure is fairly similar to talc; however, instead of being created in T-O-T layers, chrysotile has a tightly curled T-O layer structure, in which one layer is a silica tetrahedral layer, and the other is an octahedral layer made up of magnesium ions and hydroxide groups (Figure 3). Anthophyllite, with a chemical formula of Mg₇Si₈O₂₂(OH)₂, is often found in magnesium rich, metamorphosed, ultramafic rocks but can have a more iron-rich composition. Tremolite can also be found in metamorphic, ultramafic rocks, but has a chemical formula is Ca₂Mg₅Si₈O₂₂(OH)₂. Tremolite can easily be differentiated from anthophyllite by the calcium in its chemical structure.

Contamination of Talc with Asbestos

Contamination of talc with asbestos starts in the mining process. If the talc is not mined carefully enough, it is possible that asbestos minerals can be extracted as well. Since talc, as well as the many rocks that contain the minerals found in asbestos, are metamorphic, they will both be found within fault lines where the pressure and temperature is high. In the presence of carbon dioxide, serpentine transforms into talc and magnesite (eq. 1).
In addition, at high temperature and pressure, talc becomes unstable and breaks down into several products. Figure 4 shows that when talc reaches a temperature of approximately 700°C and a pressure of 2 Kilobars, it begins to break down into anthophyllite, quartz, and water.\textsuperscript{13} There are several ways in which asbestos minerals can contaminate talc; therefore, it is important that talcum powder as well as talc-containing products are tested for potential asbestos contamination before going into the hands of the consumers.

**Diseases Associated with Asbestos**

There are many diseases directly linked to long-term exposure or inhalation of asbestos. No amount of exposure to asbestos is healthy; however exposure to airborne asbestos fibers can lead to diseases that include asbestosis, lung cancer, and mesothelioma.\textsuperscript{15} Asbestosis, caused by the inhalation of asbestos, leads to labored breathing that worsens over time due to a decrease in diffusing capacity in the lungs. This disease commonly affects the lower region of the lungs and can only be diagnosed by evaluating the lung tissue using critical light microscopy.\textsuperscript{16} Pleural plaques are often found in patients with asbestosis and are white or yellow smooth surfaced lesions on parietal, visceral, and diaphragmatic pleura. These lesions are often used as evidence that
someone has been exposed to asbestos. Lung cancer is responsible for the largest number of deaths involved in patients who are exposed to asbestos. Individuals who are exposed to asbestos, but also subject their bodies to other types of carcinogens such as cigarette smoke, are more likely to contract lung cancer. Mesothelioma is a type of cancer related to asbestos exposure, but not associated with smoking cigarettes. It is often found in those people who were exposed to large amounts of asbestos in their lives. If the mesothelioma is malignant, it will often spread to the surfaces of the lung, thoracic, and abdominal cavities. If an individual is exposed to any amount of asbestos, especially in the long-term, it could lead to adverse health effects that are irreversible.

**Talcum Powder Lawsuits, Recalls, and Legislation**

Talcum powder has been in the media recently with breaking news about lawsuit victories. Many lawsuits have been filed against Johnson & Johnson by individuals who have been diagnosed with ovarian cancer or mesothelioma after long-term use of their products containing talcum powder. The total cost to Johnson & Johnson is currently over $841.4 million in damages. The first talcum powder lawsuit was filed by ovarian cancer survivor Diane Berg in 2013, which did not result in monetary compensation. Berg was asked by the company to settle out of court for $1.3 million and stay quiet about the settlement, but she refused in order to educate the public about the dangers of using talcum powder in the pelvic area. Since Diane Berg's lawsuit was filed in 2013, eight more lawsuits have been filed by people diagnosed with ovarian cancer. Mona Estrada (2014), Barbara Mihalich (2014), and Nora Daniels (2017) all filed lawsuits, but their cases resulted in no damages for the plaintiffs. The other five cases from 2016 and 2017...
resulted in monetary awards. These cases included Jackie Fox ($72 million), Gloria Ristesund ($55 million), Deborah Giannecchini ($70 million), Lois Slemp ($110.4 million), and Eva Echeverria ($417 million). In addition to the lawsuits filed for ovarian cancer, there has been one case where money has been awarded to a person diagnosed with mesothelioma. Stephen Lanzo was awarded $117 million in April of 2018 for contracting mesothelioma after using Johnson & Johnson's Baby Powder and Shower-to-Shower products for more than 30 years. These are the most well-known of the talcum powder lawsuits; there are many more not covered by the media.

In addition to lawsuit victories, there have been cosmetic recalls in the news. Two pre-teen stores, Claire's and Justice, have talc-containing cosmetic products that are being investigated by the FDA for potential asbestos contamination. In December of 2017, Claire's issued a recall for nine cosmetic products after testing by the Scientific Analytical Institute (SAI) showed that they contained asbestos. After the recall, Claire's disputed the methods used by the SAI when testing by two independent laboratories showed that these products contained no asbestos. In March of 2018, the U.S. Public Interest Research Group (PIRG) tested 15 talc-containing makeup products, of which three were found to contain asbestos by STAT Analysis Corporation, a laboratory accredited for asbestos testing. Claire's continues to say their products are safe and asbestos-free. Justice in September of 2017 voluntarily recalled eight of their "Just Shine" products after the media broke the story that they possibly contained asbestos. Justice states that they are dedicated to providing safe products for their customers and are investigating the claim with the help of the FDA and Health Canada. These recalls were made with the
safety of the consumer in mind, especially since the affected parties were children under the age of 13.

The idea that makeup made for children could potentially contain asbestos has inspired the writing of new legislation. Congresswoman Debbie Dingell of Michigan has written a bill called the Children's Product Warning Label Act of 2018. This bill will solve the problem of subjecting children to asbestos in talc, preventing the effects that we see in adults today. Introduced to the House of Representatives in February of this year, 2018, this legislation will amend the Food, Drug, and Cosmetic Act that of 1938 to require all children's cosmetics containing talc to have warning labels unless the product has been proven to be asbestos-free. Overall, this is a new piece of legislation that has a long trek remaining before it becomes a law.

**Instruments used to Identify Asbestos in Talc**

Various instrumental methods have been used in testing talc-containing products for asbestos and other potential contaminants. Usually, these methods include both microscopic technique and spectroscopic techniques. The FDA proposal for talc regulation in 1973 used polarized light microscopy (PLM), which required mixing a sample of talc with 1.574 and 1.590 refractive index liquids, observing the samples using PLM, and counting the number of fibers that fit certain criteria. It is estimated that approximately 20,000 particles would have to be examined for each talc-containing product, a time consuming process. A.M. Blount suggested a technique using a microcentrifuge to separate the amphibole minerals and talc by density and then viewing the amphibole fibers using PLM to get a more accurate count in a shorter period of time.
Another type of microscopy, electron microscopy, can be used for this type of analysis. There are two types of electron microscopy, scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The difference between these techniques is the type of image that they produce. According to Skoog et al., the SEM images the external morphology of the specimen whereas the TEM images the internal structure.\textsuperscript{25} Even though the images produced by each of these instruments is different, they are the most relied upon method for this type of analysis. Sections of the talc-containing sample are observed, and any asbestos fibers found are counted and photographed. After using SEM or TEM, the next step is to use a spectroscopic technique to confirm the microscopic results. The technique most commonly used is X-ray diffraction (XRD), which utilizes X-rays to gather structural information of the sample. A beam of X-rays interacts with the object in question, and the backscatter from the specimen undergoes constructive and destructive interference, which is the process of diffraction.\textsuperscript{26} The peaks that are created by diffraction are determined by the arrangement of the atomic structure and the kinds of crystals present in the sample.\textsuperscript{26} The diffraction patterns generated can be compared to a standard library to determine what the sample contains. Some electron microscopes come with this capability built into the instrument; however, if the instrument is older, one might have to use a separate instrument to obtain these results.
Methods

Cosmetic Sample Preparation:\textsuperscript{27}

A set of standard Scanning Electron Microscopy stubs were thoroughly cleaned with 100% ethanol prior to sample preparation and placed into the sample tray. Using a set of forceps, the coating on one side of a double-sided carbon adhesive pad, shown in Figure 5, was removed and a stub was placed onto the adhesive. The stub was then removed from the adhesive sheet to expose the other side of the carbon adhesive pad. A small amount of the cosmetic powder sample was applied to the adhesive pad using a PTFE coated micro spatula (Figure 6), the excess powder was tapped off, and the stub was blown off with air to ensure no unsecured sample was left behind. The sample was checked to confirm that it was firmly attached, and the stub was placed back into the sample tray. The completed SEM sample

\begin{figure}[h]
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\includegraphics[width=0.8\textwidth]{image1.png}
\caption{The double-sided carbon adhesive pads attached to the adhesive sheet with the coating still intact.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{image2.png}
\caption{A small amount of Covergirl Foundation being applied to the exposed carbon adhesive pad.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{image3.png}
\caption{An example of a completed SEM sample stub.}
\end{figure}
stub is shown in Figure 7. This procedure was followed for each cosmetic sample and the asbestos control.

**FEI Phenom Desktop Scanning Electron Microscope Procedure:**

The FEI Phenom Desktop Scanning Electron Microscope (SEM) was turned on and allowed to come out of hibernation mode (Figure 8). Upon finishing this cycle, the first control sample was loaded into the sample holder (Figure 9). The sample was lowered into the sample cup, 2mm from the top edge, by twisting the adjustment knob 4 additional clicks to ensure that none of the sample was above the sample holder (Figure 10). The sample holder was then inserted into the SEM until it clicked into place and the LED light turned green (Figure 11). The door to the instrument was shut firmly, and an orange light showed that the door was locked (Figure 12). The SEM automatically moves the sample holder into the optical imaging position where the
Sample can be viewed on the monitor. The first sample was viewed, analyzed, and the captured images were stored onto a USB drive, and removed from the instrument. The unload button was pressed, and the SEM moved the sample to the unload position. Once the unlock LED turned green, the door was opened to the fullest extent, and the sample was removed from the instrument. This process was repeated for the six cosmetic and asbestos control samples.

Sample Analysis:
The first sample was divided into five different sections. In each of section, the sample was scanned at approximately 1400x magnification since this is where the asbestos fibers are fully visible under the microscope. From each of the sections three photographs were taken using both of the instrument’s detectors on the “Full” setting. One was taken at approximately 1400x, one between 6000 and 8000x, and one between 14000 and 20000x magnification. At the last magnification, two additional images were taken. One using the “Topographic A” setting, and the second with the “Topographic B” setting. In each of the settings, one of the detectors, either the positive or the negative, is turned off allowing one to see the true shape of the object of interest. Once all of the photos were taken of
the six cosmetic samples and the asbestos control, the SEM stubs were placed into the sputter coater for 30 seconds to coat the samples with gold particles. After coating, the samples were analyzed again using the procedure described above.

**Sputter Coater Procedure:**
Each of the prepared SEM stubs was placed into the sputter coater, and the lid was shut. The vacuum pump was turned on to evacuate the air from the chamber (Figure 13). Once the chamber pressure was stabilized using the leak knob, the sputter time was set to 30 seconds, and the start process button was pressed (Figure 14). After the coating process was complete, the pressure in the chamber was released using the vent knob, and the samples were removed and reanalyzed.

**Results**
For this experiment, six cosmetic samples and one asbestos control were tested. Three of the six cosmetic samples were drugstore brand names while the other three were high end brand names. The samples used were Covergirl Smoothers 710 Translucent
Light ($8-9), L.A. Colors Blusher BS141 Natural ($1), Wet n Wild Color Icon Eyeshadow-302A Cheeky ($1), Kat Von D Lock-IT Powder Foundation Light 45 ($35), Nars Blush-Taos ($30), and Urban Decay Eyeshadow-Beware ($20). The asbestos control was made from asbestos containing material provided by Western Oregon University Physical Plant. Figures 15-31 are the SEM images taken of the asbestos control and cosmetic samples.

Figure 15: SEM image of non-sputtered asbestos control at 2240X magnification with a scale of 40 microns.
Figure 16: SEM image of sputtered asbestos control at 1420X magnification and a scale of 70 microns.

Figure 17: SEM image of sputtered asbestos control at 1400X magnification and a scale of 70 microns.
Figure 18: SEM image, using Topographic A sensor, of sputtered asbestos control at a magnification of 16000X magnification and a scale of 6 microns. This image is of the object depicted in Figure 17.

Figure 19: SEM image, using Topographic B sensor, of sputtered asbestos control at a magnification of 16000X magnification and a scale of 6 microns. This image is of the object depicted in Figure 17.
Figure 20: SEM image of non-sputtered Covergirl cosmetic sample. Image (a) depicts the sample at 1440X magnification with a scale of 60 microns. Image (b) depicts the sample at 6350X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 18600X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 21: SEM image of sputtered Covergirl cosmetic sample. Image (a) depicts the sample at 1480X magnification with a scale of 60 microns. Image (b) depicts the sample at 6200X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 18800X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 22: SEM image of non-sputtered Kat Von D cosmetic sample. Image (a) depicts the sample at 1400X magnification with a scale of 70 microns. Image (b) depicts the sample at 6250X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 15000X magnification with a scale of 6 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 23: SEM image of sputtered Kat Von D cosmetic sample. Image (a) depicts the sample at 1480X magnification with a scale of 60 microns. Image (b) depicts the sample at 6200X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 18800X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 24: SEM image of non-sputtered L.A. Colors cosmetic sample. Image (a) depicts the sample at 1440X magnification with a scale of 60 microns. Image (b) depicts the sample at 6850X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 20000X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 25: SEM image of sputtered L.A. Colors cosmetic sample. Image (a) depicts the sample at 1400X magnification with a scale of 70 microns. Image (b) depicts the sample at 6400X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 20000X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 26: SEM image of non-sputtered Nars cosmetic sample. Image (a) depicts the sample at 1400X magnification with a scale of 70 microns. Image (b) depicts the sample at 8500X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 20000X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 27: SEM image of sputtered Nars cosmetic sample. Image (a) depicts the sample at 1400X magnification with a scale of 70 microns. Image (b) depicts the sample at 6500X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 20000X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 28: SEM image of non-sputtered Wet n Wild cosmetic sample. Image (a) depicts the sample at 1440X magnification with a scale of 60 microns. Image (b) depicts the sample at 5800X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 14200X magnification with a scale of 6 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 29: SEM image of sputtered Wet n Wild cosmetic sample. Image (a) depicts the sample at 1400X magnification with a scale of 70 microns. Image (b) depicts the sample at 6500X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 18200X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 30: SEM image of non-sputtered Urban Decay cosmetic sample. Image (a) depicts the sample at 1480X magnification with a scale of 60 microns. Image (b) depicts the sample at 6450X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 16800X magnification with a scale of 4 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Figure 31: SEM image of sputtered Urban Decay cosmetic sample. Image (a) depicts the sample at 1420X magnification with a scale of 80 microns. Image (b) depicts the sample at 6100X magnification with a scale of 10 microns. Images (c), (d), and (e) depict the sample at 16400X magnification with a scale of 6 microns using both sensors, the Topographic A sensor, and the Topographic B sensor respectively.
Discussion

In Figures 20-31, (a) represents images taken at magnifications between 1400X and 1480X, dependent on where the image was the best focused. Images labelled (b) are taken at magnifications between 5800X and 8500X. These pictures had a larger range than (a) based on the focus of the image as well as enlarging the point of interest in the center of the image. The pictures labelled (c), (d), and (e) had a range of magnifications from 14200X and 20000X. The images with the lowest magnifications in this range were as large as the point in question could become without leaving the screen. Images labelled (c) were taken using both sensors available on the SEM, (d) images used only the Topographic A sensor, and (e) images were taken with only the Topographic B sensor. By using each of the sensors individually, a more accurate depiction of the object in question can be obtained, allowing the observer to get a better idea of the object’s structure.

The even numbered figures were not sputtered, while the odd numbered figures were. Sputtering is often done to make a non-metallic sample electrically conductive by applying a thin layer of gold atoms to the surface of the sample. This process prevents the phenomenon of charging, which occurs when the electrons used for scanning are absorbed by the material instead of reflected back at the electron detector. This causes saturation of the sensor making the display turn white with no image. In addition, the layer of gold atoms allows for a more detailed image. After having minor complications with charging, the samples were sputtered improving the overall image quality resolving the charging issues.
Since asbestos containing material was used to create the asbestos control, the images taken with the SEM were compared to images of standards from the United States Geological Survey to determine the types of asbestos present in the control. Figures 15 and 16, appear to show at least two types of asbestos. The fibers appear to be chrysotile (Figure 32), while the rod shaped objects could be either anthophyllite (Figure 33) or Tremolite (Figure 34).

After reviewing the images taken with the SEM, possible asbestiform minerals have been found in three of the six cosmetic samples: Kat Von D, L.A. Colors, and Wet n Wild. In Figure 23, the Kat Von D sample, there is a fiber present that could potentially be chrysotile asbestos. This was the only fiber found in this sample. L.A. Colors shows rod shaped objects in Figures 24 and 25. This sample had the most potential asbestos minerals out of the six cosmetic samples tested. Figures 28 and 29 show rod-like structures in the Wet n Wild sample and were the only
potential fibers found in that sample. The samples of Covergirl, Nars, and Urban Decay did not show fibers or rods that could potentially be asbestos fibers. They did, however, contain perfect spheres in the makeup samples, in Figures 20(b), 26, and 30. A review of the ingredients list for each of the three products shows the ingredient silica. Comparing the images taken from the cosmetic samples to a SEM image of silica (Figure 35), shows the unknown spheres found in the cosmetic samples is indeed silica.

The one major complication that occurred during this experiment was that the vacuum pump on the SEM as well as the computer began to malfunction prior to the testing of the Urban Decay cosmetic sample. Repair of the vacuum pump and exchanging of the computer altered the image quality and focus of this sample.

The results of this study show that the Kat Von D, L.A. Colors, and Wet n Wild samples tested may contain asbestiform minerals. In order to confirm this result, these samples should be examined using X-ray diffraction. Due to lack of funding for this project, the ability to use this instrument was unattainable. Given additional time and money, this would be how the experiment would be extended.

**Conclusion**

Despite the common misconception that cosmetics are only for women, they have been used for centuries by men, women, and children alike. This is why it is important to have enforced regulations in place to keep the general public safe. America
is heading in the right direction by creating new legislation to help regulate talc-containing cosmetics for children. The use of contaminated talc products over a long period of time could be detrimental to many lives, as seen through the numerous talcum powder lawsuits that have been filed. Even though talc is easily contaminated by asbestos in the mining process, a more refined purification process could prevent the use asbestos contaminated talc in cosmetic products. Overall, this study has indicated that the talc present in cosmetic products might not be as pure as expected. To determine the identity of the suspected asbestos contaminants, further testing of these samples using X-ray diffraction is required.
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