
Letter

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I read with great interest the paper entitled “Glass Fiber Contamination of Cigarette Filters: An Additional Health Risk to the Smoker?” by Pauly et al. (1). Dr. Pauly and his colleagues have drawn conclusions that are simply not justified. Following is a brief analysis of the scientific evidence that makes Reynolds Tobacco confident that the use of continuous glass filaments in Eclipse does not pose a risk to smokers of this cigarette.

In Eclipse, smoke is formed by hot air generated by a carbon heat source that passes through a glycerin-rich substrate, volatilizing glycerin, nicotine, other natural tobacco flavors, and added flavorants. The heat source assembly used in Eclipse consists of carbon, glass mat insulator, tobacco sandwich paper, and an insulator paper overwrap. The glass mat insulator functions to insulate the heat source, reduce propensity for the ignition of other materials, and enhance cigarette performance by directing heat flow to the substrate materials of the cigarette. The glass mat insulator is composed of continuous filament glass fiber and a binder.

It should be noted that glass filaments are ubiquitous and are commonly observed in ambient air in both occupational and nonoccupational settings. Continuous filament glass is commonly used in consumer products such as drapery fabrics, decorative ornaments, and air filters (2). Survey data demonstrates that consumers are exposed to literally thousands of glass filaments daily as a result of nonoccupational environmental exposure (2, 3).

The potential transfer of continuous filament glass to Eclipse mainstream smoke has been evaluated. The results of these studies have been presented at scientific meetings (4). In brief, methodology was developed that allowed the capture of any filaments that might be transferred to Eclipse mainstream smoke. Subsequent to handling procedures that were designed to simulate commercial shipping conditions, cigarettes were machine smoked using exaggerated conditions (10 75-ml puffs, 2-s duration, taken every 35 s). These conditions were used specifically to maximize the probability that any potential transfer of continuous filament glass to Eclipse mainstream smoke would be detected. The results of these studies consistently demonstrate that, relative to background, biologically significant transfer of continuous filament glass to Eclipse mainstream smoke does not occur.

The continuous filament glass used in Eclipse was designed to be nonrespirable. The continuous filament glass mat insulator is made from continuous glass filaments having an average diameter of 8.5 μm (range, 5.5-12 μm). These filaments are chopped to a length of 9500 μm and subsequently converted into a mat. The calculated aerodynamic diameter (parallel) of these filaments would be ~53 μm (range, 35-73 μm; Ref. 5). It is generally accepted that structures with aerodynamic diameters of >7 μm are unlikely to reach the pulmonary region of the respiratory tract (6, 7).

In addition, there are epidemiological data that specifically focus on the potential impact of occupational exposure to continuous filament glass. In the studies in which the potential impact of occupational exposure to continuous filament glass has been specifically addressed, long-term health consequences have not been associated with occupational exposure to continuous filament glass (8, 9). Furthermore, chronic inhalation studies have been conducted with rat respirable fractions of representative glass fibers (10). In these studies, rats were exposed by nose only to a rat respirable (size-selected) fraction of two representative glass fibers (MMVF 10 and MMVF 11). Although crocidolite asbestos (the positive control) was demonstrably carcinogenic to rat lung, no statistically significant increase in fibrosis or lung tumors was observed subsequent to exposure to either MMVF 10 or MMVF 11 (10).

It has been hypothesized that biopersistence plays a significant role in determining the potential bioactivity of a fiber (11). The relationship between in vivo biopersistence and chemical composition has been evaluated (12). The toxicological potential of fibers appears to be inversely correlated with the rate at which specific fibers disappear from the lung (11). For example, asbestos fibers and refractory ceramic fibers, which are relatively durable in the lung, do produce significant increases in lung tumors, mesothelioma, and/or fibrosis in the lung (10). Rock wool (MMVF 21), which is less durable than asbestos fibers or refractory ceramic fibers in the lung, produced fibrosis in rat lung but not lung tumors. Glass fibers such as MMVF 10 and MMVF 11 have been shown to be significantly more susceptible to chemical leaching processes within the lung. It has been hypothesized that this characteristic of the glass fibers accounts for their observed inactivity in animal models.

In vivo biopersistence in the lung is frequently assessed by in vitro fiber dissolution studies using simulated biological solutions and flow past techniques (13, 14). Comparative studies have been conducted that include MMVF 10, MMVF 11, MMVF 21, and crocidolite asbestos as controls. Dissolution rates were calculated from weight loss data, assuming that the rate is proportional to the reaction surface area. The results of these studies indicate that the continuous filament glass used by RJR in Eclipse is significantly more soluble than either rock wool or crocidolite.1

1 J. E. Swauger, unpublished data.

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The assertion of Pauly et al. (1) that the utilization of continuous filament glass in Eclipse represents a potential toxicological concern to smokers is unjustified. In brief, transfer data and the unique physical characteristics of the filaments demonstrate that significant exposure of the smoker will not occur. The available environmental survey data clearly demonstrate that Eclipse smokers are extremely unlikely to be exposed to continuous filament glass at a level representing an increase relative to background exposure levels. Furthermore, the chemical composition and dissolution characteristics of the filament used in Eclipse demonstrate similarity to glass fiber compositions that have failed to produce either tumors or fibrosis in chronic inhalation studies conducted in rats. In short, exposure of Eclipse smokers to continuous filament glass is extremely unlikely to occur at a level that may be construed to be of biological significance.

References


Reply

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In our analysis of Eclipse (1), glass fibers were: (a) observed protruding from the tip, (b) identified on the white cigarette wrapping paper, (c) viewed on the surface of the cork-appearing tipping paper, (d) found in the pack residue (range, 1,164–26,725 glass fibers/pack), (e) discovered lying freely on the cut surface of the filter by both light and electron microscopy, (f) harvested from the filter with adhesive tape, and (g) displaced when Eclipse was smoked mechanically (1). Also, glass filament fragments (e.g., particles, flakes, and dust) of a respirable size were seen routinely (1).

In critiquing our publication, Dr. Seth Moskowitz (2) of RJR1 argued that: “The glass filaments that made up the glass mats insulator are: (a) bound together in the mat by a fruit gelling agent; (b) when the cigarette is lit, those filaments fuse together; (c) when the cigarette is smoked, it would be virtually impossible for one of those filaments...if they somehow got dislodged from the mat, to pass through the tobacco and through the filter and into the smoker’s mouth.”

We respond that: (a) the fruit gelling agent (i.e., pectin) is inadequate to assure that no glass fibers are released during high-speed manufacturing procedures, as evidenced by the thousands of glass filaments and filament fragments that were observed routinely in our analysis; (b) relatively few glass filaments are fused as a result of smoking; and (c) we have never claimed that the glass fibers of the mats migrate through the tobacco column. The glass fibers found on the exposed surface of the filter arise from the external translocation of fragmented glass mat filaments and glass dust to the mouthpiece. Thus, Eclipse removed from the pack by the smoker is polluted with glass particles that are shattered from the insulation mats during manufacturing, packaging, and transport.

Several days later, RJR rectified its position, as follows: “R. J. Reynolds acknowledged that some glass filaments and filament fragments are present on the filters and in the packs” (3). Thus, the principal finding of our report (1) has been admitted and accepted by RJR.

Swauger (4) writes to reconstruct further RJR’s position regarding our report that documents glass contamination of RJR’s Eclipse and Premier. Our response, presented in part at this time, is as follows.

In describing the glass filaments used in Eclipse, Swauger (4) states repetitively that the filaments are “continuous.” As stated in his letter (4) and in writings by others from RJR, the glass filaments are “chopped” to give a desired length.

The reader can demonstrate the technical difficulty to be anticipated in cutting through the carbon fuel rod and glass fiber mats by attempting to slice a section from the end of an Eclipse with a razor blade. Fragmentation of the glass fibers in the insulation mats has been addressed in different United States Patents (1). A RJR memorandum of 1991 illustrates that RJR was aware of: “. . . the potential for the inhalation of glass fibers in smoking articles containing fibrous glass” (5).

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1 The abbreviation used is: RJR, R. J. Reynolds Tobacco Company.
The risk of inhaling glass fibers in the environment, an issue introduced by Swauger (4), is reasonably expected to be significantly less than that of puffing vigorously, required to sustain the burning of the carbon fuel rod, on a glass-fouled Eclipse filter that had been placed into the mouth and sealed by the smoker’s lips to ensure the inhalation of mainstream smoke.

Glass fibers lying freely on the exposed filter surface were released when the Eclipse was smoked with a smoking machine (1). Likewise, assays of the filters of conventional filter cigarettes have shown that cellulose acetate fibers and particles are released from the filter surface during smoking (6). The existence of these broken and loose fiber fibers on the exposed filter surface has been confirmed (7), and three methods to “decontaminate” the cigarettes have been described in United States Patents (7).

Swauger proclaims that RJR has developed a “Method to Quantitate Fiber Transfer” of glass fibers “to mainstream smoke” (8). Significant is that RJR’s protocol teaches us that: “A series of decontamination procedures was performed in preparation for fiber transfer analysis . . . .” Specifically, each cigarette was “decontaminated” before analysis using a method in which: “A 1/8-inch orifice air nozzle set at 10 psi (pounds per square inch) was used to blow any fibers from the outside of the cigarette. Then, the cigarette was handed to another person who rolled the cigarette on tape with slight adhesive properties to remove fibers. Both ends of a cigarette were touched to the adhesive surface.” Thus, as defined in this and other RJR writings, this standard protocol was used in which different types of Eclipse-like cigarettes were “decontaminated” of glass fibers before they were analyzed for glass fiber transfer during smoking. This decontamination protocol most likely accounts for the failure of RJR’s scientists to identify the frequent and significant glass contamination in the experiments referenced in Swauger’s letter (4). The very fact that RJR designed and implemented this protocol supports our belief that RJR knew of Swauger’s letter (4). The very fact that RJR designed and implemented this protocol supports our belief that RJR knew of this standard protocol was used in which different types of Eclipse-like cigarettes were “decontaminated” of glass fibers before they were analyzed for glass fiber transfer during smoking. This decontamination protocol most likely accounts for the failure of RJR’s scientists to identify the frequent and significant glass contamination in the experiments referenced in Swauger’s letter (4). The very fact that RJR designed and implemented this protocol supports our belief that RJR knew of Swauger’s letter (4). The very fact that RJR designed and implemented this protocol supports our belief that RJR knew of Swauger’s letter (4).

RJR has undertaken an assessment of inhaling glass “C” fibers to define: “. . . an allowable number of ‘C’ glass fibers” (13). A former member of DuPont’s Threshold Limit Value Committee for Studies of Neoplasia who reviewed this study of “C” glass cautioned: “Remember potentially 1 fiber in lung causes problems (granuloma)” (13). Furthermore, the reviewer warns: “The perception that we allow so many fibers (96 or 240) per cigarette will kill us” (13).

We emphasize that: (a) inhaled glass fibers of the size and composition of “C” glass fibers would require months or years to dissolve; (b) we know of no reports that “C” glass fibers would dissolve completely in the human lung; (c) a silica glass fiber, with a diameter of only 1 μm, requires ~438 years to dissolve in the lung (14); (d) biopersistence is but one of many factors in fiber-associated pathogenicity; and (e) inhaled glass is likely to trigger rapidly, within hours or days, a macrophage-mediated cascade of host-defense reactions that may include an acute inflammatory response. Other pathological reactions would evolve more slowly, and these may include chronic inflammation, “foreign body” reaction, granuloma, and carcinoma.

A 1988 Philip Morris study of 74 one-on-one interviews and five focus groups documents that smokers expressed a contemptuous response to the “fiberglass” used in RJR’s Premier (15). Premier also contained “glass microfibers” in the white wrapping paper. In 1998, a comprehensive analysis was conducted of focus groups of smokers, former smokers, and never smokers. Written responses to a questionnaire revealed that ≥97% of members of each of the three groups: (a) expressed health concerns related to the presence of glass fibers on the filter and (b) declared that the tobacco company should inform them of glass fibers used in glass fibers in cigarettes.

We assert that: (a) our investigation documenting the contamination of Eclipse with glass fibers and glass fiber-derived fragments is accurate, truthful, and reproducible and (b) many of the glass fibers as well as glass fiber flakes, particles and dust were of a size that would permit them to be inhaled readily. Furthermore, we recommend that RJR inform smokers of their potential exposure to glass fibers and glass dust in Eclipse and Eclipse-like products: glass fibers that may be dangerous in any concentration and under any circumstances are hazardous agents under all circumstances, and a manufacturer’s duty to warn is based upon a worst-case scenario.

2 J. Hastrup and K. M. Cummings. Beliefs about cigarettes and cigarette filters, manuscript in preparation.
References


13. Minnesota v. tobacco companies. No standards exist that are directly applicable for “C” glass material in our use configuration, Document No. 50872 0772-0774.


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