

Appendix II

Investigation into Non-photolithography Uses

As indicated in the meeting with EPA on July 10, the SIA/SEMI coalition initiated a survey of potential use of PFAS in operations outside of photolithography. The inquiry was intended to determine whether a broader exemption from the SNUR might be needed to protect critical processes in the manufacture of electronic devices. This appendix summarizes how the survey was conducted and the results of the effort.

Conduct of this analysis has required a substantial effort from the device manufacturers and the broad network of suppliers who support this industry. Despite some of the challenges described below, the hard work of the participants has yielded valuable information about the implications of the SNUR for the electronics industry.

Challenges Inherent in the Effort

While a survey of non-photolithography uses was important to the industry and valuable to EPA, we recognized from the outset that we faced certain challenges that would limit the level of certainty we could achieve. First, in considering operations outside of photolithography, the survey needed to cover a wide array of activities. There are many steps in the production of electronic devices, many of which involve complex technologies and multiple materials.

Second, a wide range of suppliers would necessarily be involved. One of the elements of our success in characterizing the photolithography process has been that the number of suppliers for the key materials is quite small. This facilitated a process that was both comprehensive and efficient. The supplier universe for other operations at our facilities is much broader. SEMI made best efforts to alert and recruit some of those suppliers to the survey effort, but not all of the suppliers for other operations are even members of SEMI. We were not able to assemble a team of suppliers to assemble industry-wide information. As a result, individual device manufacturers looked to their particular suppliers for some of the key information.

Third, it often proved difficult to overcome concerns about proprietary information that limited the flow of information among the participants in the supply chain. The PFAS moiety is often present in materials used in our industry at very small levels. Some suppliers to the device manufacturers could not determine if the PFAS moiety was present based on the information they had been provided by their upstream suppliers. Since that information was often confidential business information (CBI), companies were unwilling to share it.

Finally, the SIA/SEMI coalition had made a commitment to EPA that it would complete this survey in three months, in recognition of EPA's interest in completing its work on the SNUR. This timeline was very ambitious for what we needed to accomplish, and events required modifications in our plan along the way in order to meet that deadline.

The Steps in Our Investigation

As an initial matter, SEMI conducted a screening survey asking its members to identify applications where PFAS materials might be used in non-photolithography processes. That effort produced useful information, but it became clear that it was not feasible to organize a supplier team, similar to what we have for photolithography, for the much wider array of applications outside of photolithography.

We then proceeded with a survey, a sample of which is Attachment A to this appendix. The survey form was sent by major device manufacturers to their suppliers. This effort also generated useful information, but it was not able to produce the detailed information that we had hoped to find. It was difficult for the device manufacturer suppliers to determine the type of detailed chemical characterizations that might be relevant to the SNUR. These suppliers were receiving trade name products from their chemical supply chain. The documentation for these products, including the MSDS and other quality control information, did not typically provide sufficient specificity to confirm the presence or volume of PFAS in these products. Follow-up efforts often led to expressions of concern about CBI protection.

At this point, which occurred in August, the SIA/SEMI coalition decided to meet with 3M to determine what information they could provide about the use of 3M PFOS products in the electronics industry. These consultations were helpful, but 3M could only identify general categories of potential use. They did not have specific information about their customers' product content that could be shared with us.

Based on the information from all of these sources, the device manufacturers then undertook the following analysis. They determined that PFOS could potentially be present in 26 specific applications, which are identified in Attachment B of this appendix. The device manufacturers then examined their operations and identified those applications where PFOS was likely to be present. They also rated those applications on a "criticality scale", provided in Attachment C of this appendix. In this analysis, the device manufacturers focused primarily on PFOS, rather than PFAS, because they found the 3M communications the most instructive source of information.

Results of the Survey

The eight major electronics manufacturers participating in the effort collated their responses, which yielded the following results. PFOS was being used in 15 of the 26 major suspected applications in the survey. Of those fifteen applications using PFOS, six were considered critical (i.e., scoring at least a 4 on the attached "criticality scale".) Four of the critical situations were only raised by one company.

There were two critical applications raised by more than one company. First, PFOS is in some buffered oxide etch, which is used in a process to remove SiO₂ from silicon wafers to release micro-fabricated suspended structures, to pattern wafers and to prepare wafers for thermal oxidation. Second, PFOS has been identified in some spin-on low-K (highly insulating) dielectric materials, which are used as insulators to limit capacitance between barrier metals in the semiconductor structure. In this application PFOS serves as a surfactant. In addition, a

participant indicated that PFOS was present in polyimide and polyimide developer. This information is confirmatory of other data we had received in the survey of photolithography.¹

Conclusions from the Survey

Based on the results of the survey, the SIA/SEMI coalition has decided not to recommend an expansion of the requested exemption for specific photolithography applications. This decision does not reflect a conclusion that the SNUR has minimal impact on the industry.

In fact, we believe that PFOS-containing materials are being used for critical applications outside of photolithography. At the same time, available information suggests that the challenges we face might be addressed by measures short of a regulatory exemption. A majority of suppliers contacted responded that they are not using PFOS in non-photolithography applications. Most suppliers utilizing PFOS in non-photolithography applications responded that they are currently evaluating PFOS replacements. In addition, where PFOS use in a particular application is a unique problem for a particular company, they can separately pursue their technological and regulatory options. Some of these companies may decide to file Significant New Use Notifications under the SNUR if they cannot find acceptable alternatives.

We did identify some specific situations where more than one company may have a problem because critical uses could be affected by the SNUR. In all those cases, the affected companies are actively pursuing substitutes. Depending on the results of these efforts, they may be able to accomplish necessary process conversions in a timely way. If those plans are not successful, then the affected companies may approach EPA to discuss regulatory options.

We believe our analysis and conclusions in this area underscores the importance of considering an exemption for critical applications in photolithography. For photolithography, we are not hopeful that viable alternatives can be identified in the immediate future.

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¹ We have generally viewed polyimide applications as part of the photolithography process and thus included it in our survey of uses for that process. Since there had been some ambiguity about whether polyimides should be included in the photolithography or non-photolithography assessments, they were included in both. As indicated elsewhere in this submission, the SIA/SEMI coalition has decided not to seek an exemption for this material in any event.

COMPANY LETTERHEAD

**Materials Supplier Perfluorooctanysulfonate (PFOS) /
Perfluoroalkylsulfonate (PFAS) Survey**

[COMPANY NAME] Confidential

Dear **KEY CONTACT**,

[COMPANY NAME] is currently characterizing all its uses of materials that may contain any quantity of PFOS* and PFOS Homologues (PFAS)*. This characterization excludes use of PFAS materials in products for Photolithography, viz., resists, antireflective coatings (TARCs, BARCs), edge bead removers (EBRs), developers and polyimides as noted below². This information is necessary for us to evaluate the impact of anticipated regulatory limitations or prohibitions, with respect to future uses of these compounds. To enable the timely completion of this characterization process, we urgently request your response to this survey.

The semiconductor industry's use of PFOS and its homologues is being driven by a number of factors, the most urgent of which is pending regulatory action by the U.S. Environmental Protection Agency (EPA). The focus of our negotiations with the EPA has been on gaining an exemption from the proposed ruling for those critical applications associated with the fabrication of electronic components. Your participation in this survey is to establish:

- PFOS/PFAS content in the products shipped to [COMPANY NAME]
- Your company's plans with respect to replacing or reformulating these products
- Any known material performance implications of such compound replacement

² Most Photolithography suppliers of resists, top and bottom anti-reflective coatings, edge bead removers, developers, and polyimides have completed a comprehensive joint study of PFOS for the purposes of negotiating an exemption with EPA (Joint Study done by SIA/SEMI PFOS Working Group, and results compiled by SEMI). Therefore, those data have already been compiled and are not required again for the purposes of this survey, except for individual product replacement roadmaps. A supplier acknowledgement of participation in the joint study is adequate for purposes of this survey (individual product roadmap discussions between suppliers and their customers will be somewhat dependent upon completion of the exemption process).

Be assured that the confidentiality of your responses to this survey will be protected under the confidentiality agreement between [Supplier] and [Company Name].

[COMPANY SPECIFIC INFO/COMMENTS IF NEEDED]

Please return your information to me by August 10, 2001. If you have any questions or concerns, you may contact me at the number below. Thank you for your cooperation.

YOUR NAME HERE, YOUR TITLE
(XXX) XXX-XXXX
[COMPANY NAME]

Definition:

- **Perfluoroalkylsulfonates (PFAS)** - the **generic class** of chemical substances in which a sulfonyl group is attached to a completely fluorinated alkyl chain consisting of n+1 carbon atoms - $CF_3(CF_2)_nSO_2X$
- **Perfluorooctanylsulfonates (PFOS)** – PFAS type compounds where n=7
- **PFOS Homologues** - PFAS compounds where n=0 to 11, except where n=7 (this is PFOS).

Survey questions:

Please answer the following questions as completely and accurately as possible.

1) Do any products you ship to [COMPANY NAME] contain PFOS or PFAS (as defined on the cover letter)? Yes No

If "Yes", complete one of the attached form for each product and return to me at [Company name]

Materials Supplier PFOS /PFAS Survey

(Name of company)

(Name of respondent)

(Date)

(Phone number of respondent)

Product PFOS \ PFAS Detail Sheet

Please provide the information requested below. For reference, the full text of the PFOS Significant New Use Rule (SNUR) can be found at the following web address:

<http://www.epa.gov/fedrgstr/EPA-TOX/2000/October/Day-18/t26751.htm>

Company Name: _____

Date: _____

1. Chemical Product: _____

2. Does this product contain one or more compounds (in *any* percentage) listed in Table 2 or Table 3 of the proposed SNUR? YES NO

If YES, please provide the following for each PFOS constituent:

Chemical Constituent	CASRN	% (by weight)	No. of Carbon Atoms

3. Does this product contain one or more perfluoroalkyl sulfonates (PFAS) NOT listed on Tables 2 or 3 of the proposed SNUR? YES NO

If YES, please provide the following:

Chemical Constituent	CASRN	% (by weight)	No. of Carbon Atoms

4. How much (kg) of this product was shipped to [COMPANY NAME] in the year 2000?

5. Who is the original manufacturer of the compound(s) listed above?

What are your plans for replacement of these compounds, if necessary?

Non-Photolithography Uses of PFOS

Eight major electronics manufacturers participated in an effort to identify non-photolithography applications of PFOS. They identified PFOS in 15 of the 26 major suspected applications in the survey by some of the responding suppliers; these are identified by an asterisk (*).

FAB PROCESSES

- *Polyimides
- *Polyimide Developer Aqueous
- *Wet Etchants
- *Resist Strippers
- *Low-k Dielectrics
- *Plating Chemistries
 - CMP Slurries
 - Residue Removers
- *Chrome Etchant
- *X-ray Mask Etch
- *Heat Transfer Fluids
- *Older Tech OSGs

PACKAGING

- Plating Chemistries
- Mold Compounds
- Die Attach Compounds
- Underfill
- Solvent-based Cleaning
- Aqueous-based Cleaning
- *Marking
- *Solvent for Lens Cleaning
- *Solder Paste

OTHER ELECTRONICS APPLICATIONS

- PWB Coating
- *Lubricant Coating
- *Epoxy Adhesive

FACILITIES/EQUIPMENT MAINTENANCE

Paint

Pump Oils

CRITICALITY SCALE

Indicate criticality of Application using the Number Scale Defined as Follows:

- 1 - Not Critical: will not be used past 2003 or replacement has been implemented.
- 2 - Alternative chemical currently being qualified; qualification completed prior to 12/31/2003.
- 3 - Supplier has provided timeline for replacement chemical to be available and qualifications will be complete prior to 12/31/2003.
- 4.a. - Supplier is currently evaluating replacements and has identified/believes that there are one or more viable alternatives; supplier expects to provide a replacement timeline once one of these alternatives is confirmed.
- 4.b. - Supplier is currently evaluating replacements, but has not yet identified any possible alternatives; supplier is unable to provide a replacement timeline.
- 5.a. Supplier has not communicated any plans, and the SIA member company has identified no viable non-PFOS (non-PFAS) alternative.
- 5.b. Supplier is not intending to replace the chemistry, and the SIA member company has identified no viable non-PFOS (non-PFAS) alternative.