Memorandum

Date: February 20, 2003

From: Division of Food Contact Substance Notification Review
Chemistry Review Group II

Subject: FCN 311: DuPont Chemical Solutions Enterprise submission dated 12/16/02 for the use of the copolymers of 2-perfluoroalkylethyl acrylate, 2-N,N-diethylaminoethyl methacrylate, and glycidyl methacrylate as an oil or grease resistant treatment for paper and paperboard intended for use in microwave heat-susceptor packaging contacting of all types of food.

To: Division of Food Contact Substance Notification Review
Regulatory Group II
Attn: Kelly Williams, D.V.M., M.P.H.

Keller and Heckman (K&H) submitted this notification on behalf of DuPont Chemical Solutions Enterprise for the use of the copolymers of 2-perfluoroalkylethyl acrylate, 2-N,N-diethylaminoethyl methacrylate, and glycidyl methacrylate as an oil or grease resistant treatment for paper and paperboard. The maximum level of food-contact substance (FCS) will not exceed 0.18 wt-% of fluorine based on the weight of the paper. This level corresponds to 0.33 wt-% of the FCS on the weight of the paper. This FCS will be used in microwave heat-susceptor packaging that may contact all food types.

This FCS was the subject of FCN 206: DuPont Chemical Solutions Enterprise submission for the use of fluorinated copolymers as grease and oil resistant coatings for paper and paperboard food-contact articles to be used in contact with all types of food under conditions of use B through H.

The chemistry information is contained in FDA Form 3480 and Attachments 1-10.

Identity of FCS

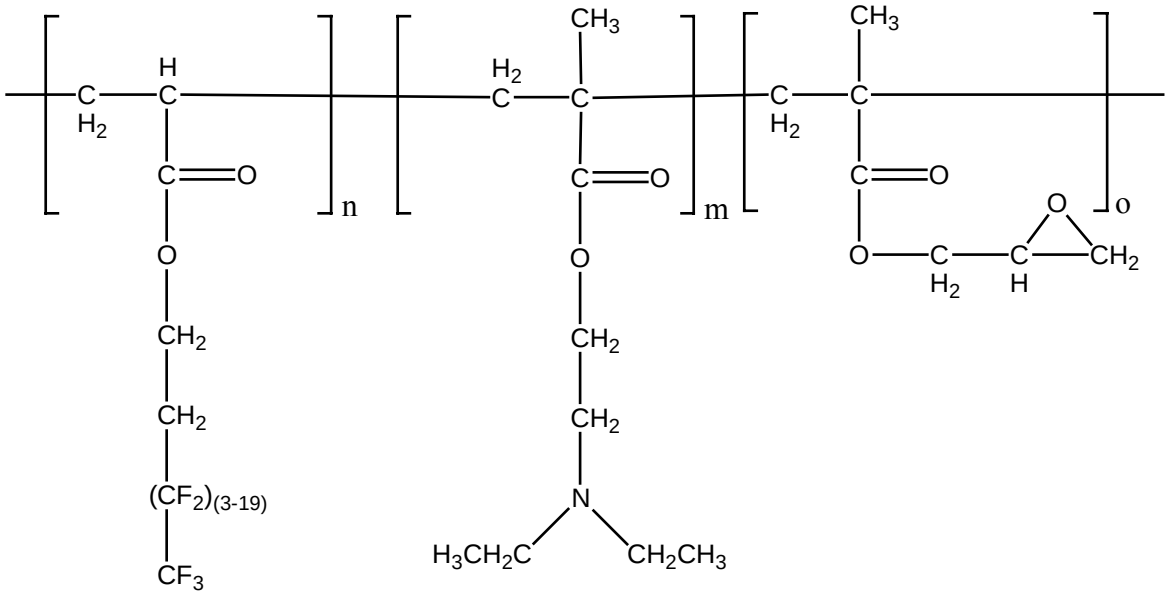
CAS name: 2-propenoic acid, 2-methyl-,2-(diethylamino)ethyl ester, polymers with glycidyl methacrylate and gamma-omega-perfluoro-$C_{6\text{-}20}$-alkyl acrylate, acetates (salts)

CAS number: 247047-61-6

Other names: [redacted], copolymers of 2-perfluoroalkylethyl acrylate, 2-N,N-diethylaminoethyl methacrylate, and glycidyl methacrylate. [redacted] (the product originally in FCN 206) is identical to [redacted]

Formula: $(C_{9\text{-}25}H_7O_2F_{9\text{-}41})_n(C_{10}H_{19}O_2N)_m(C_7H_{10}O_3)_o$

Structure:



(b) (4)

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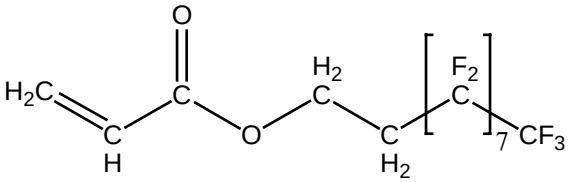
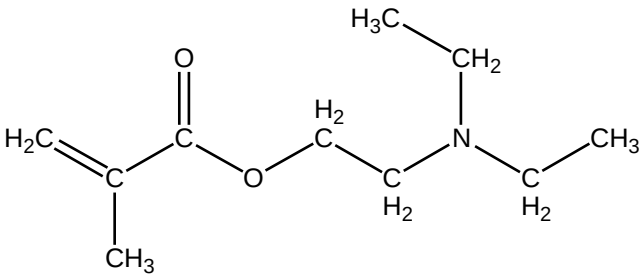
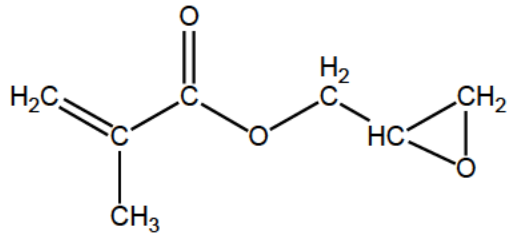
Monomers and CAS numbers:



2-perfluoroalkylethyl acrylate (ZFAN), 65605-70-1



2-propenoic acid, 2-methyl-, 2-(diethylamino)ethyl ester (DEAM), 105-16-8



glycidyl methacrylate (GMA), 106-91-2

Physical properties (Attachment 6):

Table 1 Physical Properties of (b) (4)

[redacted]

The identity of the FCS was confirmed by ^{1}H and ^{13}C NMR spectra included in Attachment 3. The identity of the FCS was also verified by infrared spectra in Appendix II of FCN 206.

Manufacture (Section B, p. 4-5, Attachment 4)

(b) (4)

[redacted]

Impurities (Section B, p. 5 & Attachment 5 & 6)

Table 2 Impurities in (b)

Chemical Name	CAS Reg. No.	Typical Residue (%)	Maximum Residue (%)
ZFAN	65605-70-1	(b) (4) [redacted]	
DEAM	105-16-9		

GMA	106-91-2
Telomer BA	
Diethylaminoethanol (DEAE)	100-37-8

(b) (4)

ZFAN, DEAM, and GMA are starting materials and are present at low levels in the final product. In the chemistry memo for FCN 2061, exposures for glycerin and glycerin methacrylate were calculated. These compounds are produced by hydrolysis of GMA. The notifier did not address the presence of these compounds in this notification. From the previous notification (FCN 206), the (contains less than 10 ppm glycerin methacrylate and less than 20 ppm glycerin. (b) (4)

Telomer BA and DEAE are formed as unintended by-products from hydrolysis of the copolymer side chains (b) (4) . Telomer BA (also called (is a $C_{6\text{-}22}$ range of 2-perfluoroalkylethyl alcohols ($F(CF_2)_nCH_2CH_2OH$, where n=3, 5, 7, 9, 11, 13, 15, 17, see Table 3) and is also one of the starting materials for ZFAN. The components of Telomer BA are listed in Attachment 8 and are as follows:

Table 3 Composition of Telomer BA

Compound	CAS Reg. No.	Amount in Telomer BA (%)
1,1,2,2-Tetrahydroperfluoro-1-Hexanol	2043-47-2	0.340
1,1,2,2-Tetrahydroperfluoro-1-Octanol	647-42-7	32.170
1,1,2,2-Tetrahydroperfluoro-1-Decaonol	678-39-7	27.300
1,1,2,2-Tetrahydroperfluoro-1-Dodecanol	865-86-1	19.490
1,1,2,2-Tetrahydroperfluoro-1-Tetradecanol	39239-77-5	10.390
1,1,2,2-Tetrahydroperfluoro-1-Hexadecanol	60699-51-6	4.330
1,1,2,2-Tetrahydroperfluoro-1-Octadecanol	65104-65-6	0.590
1,1,2,2-Tetrahydroperfluoro-1-Eicosanol	65104-65-6	0.060

(b) (4)

Other telomeric impurities in ((including perfluoroalkyl alkanes, olefins, isopropyl ethers, acetates, and iodides) are present at far lower levels than Telomer BA and exposure should be essentially zero. A complete analysis of the impurities in (is contained in Attachment 5.

Intended use

This FCS is intended for use as an oil or grease resistant treatment for paper and paperboard. The maximum level of FCS will not exceed 0.18 wt-% of fluorine based on the weight of the paper.

1 Chemistry Memorandum, K. Arvidson to J. Smith, June 10, 2002, p. 12.

This level corresponds to 0.33 wt-% of the FCS on the weight of the paper. This FCS will be used in single-use microwave heat-susceptor packaging that may contact all food types.

Technical effect

The intended technical effect is described on p. 9 of FDA Form 3480. [redacted] is intended to impart oil and grease resistance to paper used in microwave susceptor applications.

(b) (4)

[redacted]

Migration studies

Migration studies and an exhaustive extraction were conducted and are described on p. 11-14 and Attachment 9. Paper test specimens weighing 23 mg/in^2, a typical paper weight for microwave susceptor applications, were prepared by passing the paper through a diluted solution of [redacted] drying the treated paper, and determining its fluorine content. The paper contained 0.18 wt-% of fluorine based on the weight of the paper. This is equivalent to 0.04 mg fluorine per square inch of paper. A metallized PET susceptor was glued to one side of the [redacted] treated paper. The paper with the susceptor was folded into a rectangular-shape tray with dimensions 6.5 in x 5.5 in. x 0.5 in. The metallized PET microwave susceptor was on the outside bottom of the tray. Thus, the treated paper was between the susceptor and the food simulant, which is the same structure that occurs in commercial microwave popcorn bags. The surface area of the tray was 47.8 in^2. 142 mL of corn oil was added to the tray to simulate all foods. This gives a ratio of solvent volume to sample surface area of 3 mL/in^2. The corn oil was heated for 5 minutes at full power in a 700 Watt oven. At the end of the experiment, the extracts were clear, but yellow in color with no precipitate. The migration studies reflect the most severe conditions of use (corn oil, 5 min at full power in a 700 Watt oven). Migration study extracts were analyzed for ZFAN, DEAE, and Telomer BA.

Exhaustive extractions of FCS-treated paper were conducted by exposing 116 in^2 of treated paper to 300 mL of dichloromethane. The sample was extracted for 8 hours in a Soxhlet extractor.

Exhaustive extraction aliquots were analyzed for DEAM and GMA. Neither compound was found; for DEAM, one-half the limit of detection (LOD) was assumed, however for GMA the specification limit is set at <0.001%, so 100% migration was assumed.

Exposure to the oligomers was calculated based on 100% migration assumption. In addition, exposures to glycerin and glycerin methacrylate (hydrolysis products of GMA) were calculated based on the assumption of 100% migration.

Exposure estimates

Exposure to oligomers

The exposure to the oligomers was calculated by assuming 100% migration of the fraction of the polymer with molecular weight below 1000 Daltons (Da). The notifier estimated that 0.84% of the polymer is below 1000 Da (Attachment 7). Thus, the maximum level of (b) (4) oligomer migration is calculated as follows:

$$< M > = \frac{23\,mg\ paper}{in^2\ paper} x \frac{0.0033\,mg\ (b)\ (4)}{mg\ paper} x \frac{0.0084\,mg\ oligomer}{mg\ (b)\ (4)} x \frac{1\,in^2\ paper}{5000\,mg\ food} =$$

$$1.28 x 10^{-7}\ mg\ oligomer / mg\ food = 128\ ppb$$

The dietary concentration (DC) was calculated by the following equation:

DC = CF x <M>

Where the consumption factor (CF) is 0.001 for microwave susceptor applications.

The estimated daily intake (EDI) was calculated by using the assumption of a 3000 g daily diet per person.

EDI = 3000 g food/p/d x DC

The DC is 0.13 ppb and EDI is 0.39 µg oligomers/p/d.

In this notification K&H submitted a re-calculation of the exposure estimate for oligomers. In FCN 206, the exposure was estimated by migration study in 10% ethanol and corn oil. In this notification, K&H reported an oligomer content of (b) of 0.84% by weight of the polymer. This value was not known at the time of FCN 206 submission. Using this value, K&H calculated a worst-case oligomer migration of the application described in FCN 206 (assuming a paper basis weight of 50 mg/in^2 and a food-to-surface area ratio of 10 g/in^2) as follows:

$$< M > = \frac{50\,mg\ paper}{in^2\ paper} x \frac{0.0033\,mg\ polymer}{mg\ paper} x \frac{0.0084\,mg\ oligomer}{mg\ polymer} x \frac{1\,in^2\ paper}{10{,}000\,mg\ food} =$$

$$1.39 x 10^{-7}\ mg\ oligomer / mg\ food = 139\ ppb$$

In FCN 206, a migration study with corn oil as the food simulating solvent, yielded 216 ppb oligomeric extractives. Due to analytical limitations, the extract was not characterized by molecular weight. In this FCN, K&H argue that a molecular weight profile will allow an exposure estimate to be provided for the fraction of toxicological interest, namely that material with a molecular weight below 1000 Da. This would lead to a calculation as follows (using the migration results for the 10% ethanol study and the 100% migration calculation for fatty foods):

$DC = CF \times P_{cf} \times [(M_{aq+ac+al} + f_{aq+ac+al}) + (M_{fat} \times f_{fat})]$

Where CF is the consumption factor for specialty paper (0.05), P_{cf} is a correction factor to compensate for the difference in basis weight of the paper samples used in the migration and extraction experiments (36 mg/in^2) and FDA's standard assumption of 50 mg/in^2 as the average basis weight of all paper (50 mg/in^2 ÷ 36 mg/in^2 = 1.39), $f_{aq+ac+al}$ and f_{fat} are the food-type distribution factors for coated paper per our "Recommendations" ($f_{aq+ac+al}$ = 0.60 and f_{fat} = 0.40), and M is the migration value.

DC = 0.05 x [(25 ppb x 1.39 x 0.60) + (139 ppb x 0.40)] = 3.8 ppb

This re-calculated DC is lower than the 7.0 ppb reported in the chemistry memorandum for FCN 206.[1] The corresponding EDI is 11.5 µg oligomers/p/d. Thus, the cumulative estimated daily intake (CEDI) for oligomers would be 11.4 µg/p/d + 0.39 µg/p/d = 11.9 µg oligomers/p/d.

Exposure to ZFAN

The exposure estimate for ZFAN was calculated from the migration studies. The average migration of ZFAN into corn oil after 5 minutes at 700 Watts is 0.144 µg ZFAN/in^2 paper. The migration into food is calculated by assuming a ratio of 5 g food/in^2 paper. Thus,

$$< M > = \frac{0.114\,\mu g\ ZFAN}{in^2\ paper} \times \frac{1 in^2\ paper}{5 \times 10^6\ \mu g\ food} = 23 \times 10^{-9}\ \mu g\ ZFAN / \mu g\ food = 23\ ppb$$

DC = 0.001 x 23 ppb = 0.023 ppb

EDI = 3000 g food/p/d x (2.3 x 10^{-5} µg ZFAN/g food) = 0.069 µg ZFAN/p/d

The EDI for ZFAN from FCN 206 was 4.2 µg/p/d. Thus, the CEDI is 4.2 µg/p/d + 0.069 µg/p/d = 4.3 µg ZFAN/p/d.

Exposure to Telomer BA

The exposure estimates to Telomer BA were calculated from the migration studies as above. The average migration into food was 1.07 µg/in^2 (214 ppb). The DC = 0.214 ppb and EDI = 64 µg Telomer BA/p/d.

FCN 206 contained an exposure estimate to Telomer BA. In the current notification, K&H argue that the FDA-calculated exposure estimate over-estimates the exposure. They state that "*an ambiguity in the description of the sample work-up and analysis is responsible for this confusion. …the laboratory, correctly, employed the factor of (2 mL/4 mL) to calculate the corresponding level of*

Telomer BA in the ethanol and corn oil extracts." Thus the LOD was 20 ppb (which was the value used for migration into 10% ethanol) and the migration value into corn oil was 37 ppb. The recalculated DC is as follows:

DC = 0.05 x 1.39 x [(20 ppb x 0.6) + (37 ppb x 0.4)] = 1.9 ppb

EDI = 5.7 µg Telomer BA/p/d

We accept this re-calculation for the exposure estimates in FCN 206. Thus, the CEDI for Telomer BA is 5.7 µg/p/d + 0.63 µg/p/d = 6.3 µg Telomer BA/p/d.

Exposure to DEAE

The exposure estimates for DEAE were calculated from the migration studies as above. DEAE was not detected in the corn oil extracts and is not expected to migrate. Thus, ½ LOD was used (0.25 µg/in^2). The average migration into food was 50 ppb, the DC was 0.05 ppb, and the EDI was 0.150 µg/p/d. The EDI from FCN 206 for DEAE was 51 µg DEAE/p/d. The current CEDI for DEAE is 51.2 µg DEAE/p/d.

Exposure to DEAM

In the exhaustive extraction, DEAM was not detected. The results were validated by spiking replicate dichloromethane extracts at the limit of detection (0.010 µg/in^2, or 2 ppb in food). Migration was assumed to occur at one-half the validated LOD. Thus, the average migration into food was 1 ppb, the DC was 0.001 ppb, and the EDI was 0.003 µg/p/d. The EDI from FCN 206 for DEAM is 0.21 µg/p/d. The additional 0.003 µg/p/d from this application will not significantly increase the CEDI. Thus, the CEDI remains 0.21 µg/p/d.

Exposure to GMA

In the exhaustive extraction, GMA was not detected. However, rather than rely on the exhaustive extraction results where GMA was not detected at a level equivalent to 2 ppb migration, a worst-case migration was calculated based on the analysis of the [redacted] liquid product, in which GMA was not detected at a 1 ppm sensitivity level. Migration is calculated as follows:

$$< M > = \frac{23\,mg\ paper}{in^2\ paper} x \frac{0.0033\,mg\ polymer}{mg\ paper} x \frac{1x10^{-6}\ mg\ GMA}{mg\ [redacted]} x \frac{1mg\ [redacted]}{0.19\,mg\ polymer} x \frac{1in^2\ paper}{5000\,mg\ food} =$$

$$8\,x10^{-11}\ mg\ GMA / mg\ food = 0.08\,ppb$$

The DC is 8.0 x 10^{-5} ppb and the EDI is 2.4 x 10^{-4} µg/p/d.

This EDI does not significantly increase the current CEDI.

Exposure to Glycerin and Glycerin Methacrylate

Exposures to glycerin and glycerin methacrylate (hydrolysis products of GMA) were calculated based on 100% migration assumption. From the previous notification (FCN 206), the [redacted] contains less than 10 ppm glycerin methacrylate and less than 20 ppm glycerin. The exposure calculation for glycerin is as follows:

$$< M > = \frac{23\,mg\ paper}{in^2\ paper} \; x \; \frac{0.0033\,mg\ \text{(b) (4)}}{mg\ paper} \; x \; \frac{2\,x10^{-5}\ mg\ glycerin}{mg\ \text{(b) (4)}} \; x \; \frac{1in^2\ paper}{5000\,mg\ food} =$$

$$2.75\,x10^{-10}\ mg\ glycerin \Big/ mg\ food = 0.3\ ppb$$

The corresponding DC for glycerin is 3.0 x 10^{-4} ppb and the EDI is 9.0 x 10^{-4} µg/p/day. Glycerin is generally recognized as safe as a miscellaneous and/or general food additive under §182.1320.

The calculations for glycerin methacrylate (at a level of 10 ppm) are similar, yielding a DC of 1.0 x 10^{-4} ppb and an EDI of 3.0 x 10^{-4} µg/p/day.

Summary of Exposure Estimates

The exposure estimates are tabulated below.

Table 4 Exposure Estimates

Chemical Name	CAS Reg. No.	DC (ppb)	EDI (µg/p/day)	CEDI (µg/p/day)
Oligomers less than 1000 Da		0.13	0.39	11.9‡
ZFAN	65605-70-1	0.023	0.069	4.3†
DEAM	105-16-9	0.001	0.003	0.21✧¶
GMA	106-91-2	8.0 x 10^{-5}	2.4 x 10^{-4}	0.014✧¶
Glycerin	56-81-5	3.0 x 10^{-4}	9.0 x 10^{-4}	GRAS §182.1320
Glycerin Methacrylate		1.0 x 10^{-4}	3.0 x 10^{-4}	0.13✧¶
Telomer BA		0.21	0.63	6.3‡
Diethylaminoethanol (DEAE)	100-37-8	0.05	0.15	51.2†

†The CEDI consists of the EDI from this notification plus the EDI from FCN 206. See Chemistry Memorandum, K. Arvidson to J. Smith, June 10, 2002, p. 13.
‡See specific exposure estimate calculations above for an explanation of the re-calculated CEDIs.
✧This is the same EDI in FCN 206; this current application does not significantly increase the CEDI.

Notification Letter

The acknowledgement letter for FCN 000311, which is dated 1-16-03, is appropriate as written.

Summary

We have no questions.

Kimberly A. Smeds, Ph.D.

HFS-245 (Begley); HFS-205(Kuznesof); R/F
HFS-275: KASmeds: 418-3424: FCN311_C_memo.doc: 2-20-03
RDInit: MAAdams, 2-20-03

$$< M > = \frac{23\,mg\ paper}{in^2\ paper} \times \frac{0.0033\,mg\ (b)(4)}{mg\ paper} \times \frac{2 \times 10^{-5}\ mg\ glycerin}{mg\ (b)(4)} \times \frac{1\,in^2\ paper}{5000\,mg\ food} =$$

$$2.75 \times 10^{-10}\ mg\ glycerin / mg\ food = 0.3\ ppb$$

The corresponding DC for glycerin is 3.0 x 10^{-4} ppb and the EDI is 9.0 x 10^{-4} µg/p/day. Glycerin is generally recognized as safe as a miscellaneous and/or general food additive under §182.1320.

The calculations for glycerin methacrylate (at a level of 10 ppm) are similar, yielding a DC of 1.0 x 10^{-4} ppb and an EDI of 3.0 x 10^{-4} µg/p/day.

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DEAM	105-16-9	0.001	0.003	0.21✧
GMA	106-91-2	8.0 x 10^{-5}	2.4 x 10^{-4}	0.014✧
Glycerin	56-81-5	3.0 x 10^{-4}	9.0 x 10^{-4}	GRAS §182.1320
Glycerin Methacrylate		1.0 x 10^{-4}	3.0 x 10^{-4}	0.13✧
Telomer BA		0.21	0.63	6.3‡
Diethylaminoethanol (DEAE)	100-37-8	0.05	0.15	51.2†

†The CEDI consists of the EDI from this notification plus the EDI from FCN 206. See Chemistry Memorandum, K. Arvidson to J. Smith, June 10, 2002, p. 13.

‡See specific exposure estimate calculations above for an explanation of the re-calculated CEDIs.

✧This is the same EDI in FCN 206; this current application does not significantly increase the CEDI

Notification Letter

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Summary

We have no questions.

[redacted]

Kimberly A. Smeds, Ph.D.

HFS-245 (Begley); HFS-205(Kuznesof); R/F
HFS-275: KASmeds: 418-3424: FCN311_C_memo.doc: 2-20-03
RDInit: MAAdams, 2-20-03

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