# Polybrominated Diphenyl Ether Measurements in Household Dust

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## Introduction

Current monitoring of polybrominated diphenyl ethers (PBDEs) has suggested that concentrations are increasing in the environment very rapidly with doubling times as short as three to five years [1-2]. North America consumes a large percentage of the global world market demand for PBDEs, and as a result, concentrations of PBDEs in human milk and serum are an order of magnitude higher in women from North America relative to Europe[3-5]. A large range in the PBDE levels from human placental and cord serum in women from North America was observed in a recent study [4], suggesting that some people were being exposed to PBDEs more frequently than others. In an attempt to identify the source of the high PBDE levels, the authors looked for correlations between PBDEs levels and occupational exposure, age, or body mass index, but could find no positive influence. One source that may be responsible for these observations is household exposure. These compounds are liberally applied to many common household items such as furniture, mattresses, computers and TVs to retard or hinder the outbreak of fire. Over time, it may be possible for these flame retardants to leach out into the home environment where they may be inhaled or ingested and result in elevated levels in human serum.

Very few studies have examined PBDE levels within the home and only one study has measured the concentrations of two PBDE congeners in household dust[6]. The present study was undertaken to examine and measure the levels of a suite BDE congeners in household dust from a variety of homes and assess the contribution of the three commercial PBDE mixtures (penta-, octa- and decaBDE) to the household dust composition. Correlations with properties of the households such as age, square footage, carpeting coverage and number of electronic appliances in the house were also examined for any positive correlations. In addition, three household dust standard reference materials from the National Institute of Standards and Technology (NIST) were measured for PBDE levels and reference values will be made available for these materials.

## Materials and Methods

Sixteen household dust samples were collected using a small handheld vacuum (Euro-Pro model, 900 Watts) equipped with a hose, filter basket and HEPA filter. A standard coffee filter was inserted in between the filter basket and HEPA filter to collect fine particle dust from each household. Under these conditions, dust was collected that passed through a 1 mm mesh in the basket. In between sample collections the vacuum was thoroughly cleaned with hot water and a methanol rinse and new filters were used for each sample. In each house dust was collected in the main family room areas by vacuuming the rugs or hardwood floors until sufficient mass (0.1-0.5 g) was collected on the filter (approximately 5-15 min.). After vacuuming, the dust was scraped off the filter into pre-cleaned glass jars using methanol rinsed spatulas and taken back to NIST for extraction and quantification. All dust samples were extracted using pressurized fluid extraction with dichloromethane and cleaned up through silica sep-pak cartridges using hexane. Isotopically labeled BDE 209 (2,2',3,3',4,4',5,5',6,6'-decabromodiphenyl ether) and CDE 86 (2,2',3,4,5-pentachlordiphenyl ether) were added to each sample as internal standards.

Household dust standard reference materials (SRM 2583, 2584 and candidate SRM 2585) were prepared at NIST but were initially collected under the direction of the Research Triangle Institute and the U.S. Environmental Protection Agency. The collection process involved sampling of numerous vacuum cleaner bags from households, cleaning services, motels and hotels in the states of North Carolina, Maryland, Ohio, New Jersey, Wisconsin and Montana. Two of these reference materials (SRM 2583 and 2584) were originally collected and prepared as a reference materials for lead in household dust, while SRM 2585 is currentlyl being certified for organic contaminants.

Quantification of BDE congeners was performed using a Hewlett Packard 6890 gas chromatograph equipped with an Agilent 5973 mass spectrometer. Analysis was made using negative chemical ionization operated in select ion monitoring mode and BDEs were quantified using ions 79- and 81- (bromide ions) for the majority of the BDEs with the exception of BDE 209 which was monitored with ions 487 and 409. A 15 m, 5% phenyl methylpolysiloxane capillary column was used for the separation of the BDE congeners and all injections were performed with on-column cool injection to improve the sensitivity of BDE 209 in particular.

## Results and Discussion

Preliminary data on 14 BDE congeners measured in the 16 household dust samples found total BDE concentrations ranging from 310 ng/g dry mass to 30, 140 ng/g dry mass (Table 1). The contribution of pentaBDE (percentage of BDE 47, 99 and 100 to the total concentration) ranged from 7 to 80% of the total BDE burden among the households while the contribution of the decaBDE product (percentage of BDE 209 to the total

concentration) ranged from 4 to 90% among the household dust samples. The sum total of pentaBDE and decaBDE congeners contributed more than 82% of the total PBDE burdens in all household dust samples. Concentrations of BDE 209 alone in the household dust samples ranged from 83 ng/g dry mass to 8,750 ng/g dry mass. These concentrations are in the median to high range of concentrations typically observed in contaminated sediment and sewage sludge[7-8] and suggest that household environments may play a significant role in human exposure to these flame retardants.

SRM 2584 was originally prepared as a Standard Reference Material for high lead (1%) measurements, while SRM 2583 was prepared as a low lead (90 mg/kg) household dust reference material. Total BDE concentrations in SRM 2584 were measured at 2,830 ± 160 ng/g dry mass of which BDE 209 measured 2, 060 ± 173 ng/g dry mass. SRM 2583 had a total BDE concentration of 3,100 ± 220 ng/g dry mass of which BDE 209 contributed 2,230 ± 215 ng/g dry mass. Candidate SRM 2585 is a mixture of 69% low lead household dust samples and 31% high lead dust samples from different sample lots. This mixture contained a total BDE concentration of 4,600 ± 440 ng/g dry mass and BDE 209 was measured at 2,800 ± 330 ng/g dry mass. Measurements on other BDE congeners will be discussed at the workshop.

**References**

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**Table 1. BDE congener concentration (ng/g dry mass) measured in household dust samples (n=1) and SRMs (n=6).**

| Sample # | House Type | BDE 28 | BDE 47 | BDE 99 | BDE 100 | BDE 154 | BDE 183 | BDE 209 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Condo | 12.9 | 644 | 610 | 119 | 63.8 | 14.9 | 2910 | 4480 |
| 2 | Townhouse | 4.6 | 124 | 62.1 | 14.0 | 5.4 | <DL | 83.3 | 310 |
| 3 | House | 8.9 | 1150 | 2120 | 367 | 214 | 25.5 | 1170 | 5430 |
| 4 | Condo | 2.9 | 17.1 | 272 | 50.5 | 34.7 | 17.6 | 4310 | 4770 |
| 5 | House | 17.0 | 388 | 571 | 94.6 | 65.0 | 168 | 470 | 1860 |
| 6 | Condo | 9.3 | 178 | 210 | 39.3 | 31.1 | 65.4 | 2120 | 2710 |
| 7 | House | 59.4 | 1250 | 944 | 165 | 80.3 | 65.4 | 1530 | 4270 |
| 8 | House | 4.2 | 77.2 | 118 | 17.8 | 11.8 | 4.9 | 3740 | 3990 |
| 9 | Condo | 25.0 | 1825 | 2693 | 436 | 283 | 24.1 | 8745 | 14,540 |
| 10 | House | 37.1 | 2110 | 1465 | 249 | 116 | 12.4 | 1353 | 5640 |
| 11 | House | 76.5 | 7610 | 13,810 | 2090 | 1250 | 71.5 | 2404 | 30,140 |
| 12 | Townhouse | 25.0 | 1656 | 1910 | 321 | 144 | 27.9 | 2496 | 6874 |
| 13 | House | 24.3 | 436 | 676 | 108 | 72.8 | 18.9 | 1010 | 2485 |
| 14 | Basement Apartment | 5.4 | 325 | 381 | 60.0 | 35.4 | 7.1 | 770 | 1654 |
| 15 | House | 7.9 | 433 | 648 | 109 | 50.8 | 19.2 | 951 | 2330 |
| 16 | Condo | 14.8 | 1027 | 1330 | 215 | 111 | 15.8 | 951 | 3720 |
| | | | | | | | | | |
| | SRM 2583 | 15.4 ± 1.0 | 223 ± 14 | 389 ± 26 | 62.7 ± 4.3 | 61.9 ± 4.0 | 17.5 ± 1.7 | 2230 ± 215 | 3100 ±220 |
| | SRM 2584 | 14.4 ± 1.0 | 205 ± 5 | 337 ± 8 | 54.0 ± 0.9 | 45.4 ± 1.1 | 23.3 ± 1.4 | 2060 ± 173 | 2830 ± 160 |
| | SRM 2585 | 45.0 ± 4.9 | 480 ± 43 | 834 ± 79 | 126 ± 11 | 98.7 ± 7.7 | 39.4 ± 4.4 | 2800 ± 330 | 4600 ±440 |