



## *Project Summary*

# **Assessment of Future Environmental Trends and Problems of Increased Use, Recycling, and Combustion of Fiber-Reinforced, Plastic and Metal Composite Materials**

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A mini-assessment of increased use, recycling, and combustion of composite materials was performed. The objective of the study was to produce information which will assist EPA to decide whether a potential environmental problem is likely to occur, whether it is likely to be a significant problem, and whether research is necessary. The assessment addressed two major areas: (1) the state-of-the-art of composite materials and (2) the risks associated with their use, recycling, and combustion. The state-of-the-art was determined through a literature search and by direct contact with industry experts. Then chemical monographs were developed for composites and their components followed by an assessment of potential environmental risks. No major health related environmental risks were identified. The combustion of Kevlar® fiber and epoxy, polyester, and vinyl ester resins produces combustion products which have the potential for health related environmental problems under certain conditions.

*This Project Summary was developed by EPA's Office of Exploratory Research, Washington, DC, to announce key findings of the research*

*project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### **Introduction**

The purpose of this study for the Office of Strategic Assessment and Special Studies (OSASS) of the Environmental Protection Agency was to identify and define future environmental concerns related to the increased use, the recycling, and the combustion of composite materials. Based upon the results of this effort, OSASS will make a preliminary determination of whether further study of a concern or potential problem is warranted.

First of all, it was determined that the materials to be studied would include both "reinforced plastics" (i.e., glass-fiber reinforced plastic) and "composites" (i.e., materials reinforced with advanced fibers such as graphite, Kevlar®, boron, etc.). Twenty-one components, both fiber and matrices, were investigated. Seven materials passed original screening as the key materials for in-depth assessment: glass fiber, graphite fiber, silicon carbide fiber, Kevlar® fiber, epoxy resin, polyester resin, and vinyl ester resin. An extensive background

and literature search was performed to assess future use trends and provide data needed to perform an assessment of the related public health and environmental risks associated with the usage trends. Chemical monographs were generated and subsequently the potential for environmental risk was assessed.

## Conclusions

The usage trends associated with the principal fibers and matrices investigated were determined as shown in Tables 1 and 2.

Due to lack of quantitative data, only a qualitative indication of risk could be made. Based upon the qualitative data available, the seven materials were assigned to one of the following four groups with the recommended follow-up actions:

- **Group 1** includes materials or their combustion products which have not been listed as hazardous by EPA or for which no health or non-health hazard has been identified to date; therefore, further investigation can be postponed in favor of materials in high priority groups.
- **Group 2** includes materials or their combustion products which have been identified as presenting some potential for nonhealth related hazards and, therefore, further investigation may be warranted to resolve the uncertainties.
- **Group 3** includes materials or their combustion products which have been identified as presenting some potential for health related hazards and, therefore, further investigation is warranted to resolve the uncertainties. Follow-up actions might involve making a scientifically comprehensive risk assessment and consideration for inclusion in the appropriate EPA list and/or investigation to identify safe combustion practices.
- **Group 4** includes materials or their combustion products that have been included on an existing EPA toxic or hazardous substances list.

Based on the results of the assessment, no major hazard was identified. This applied to all materials with respect

**Table 1.** Projected Annual Production of Major Reinforcing Fibers  
1980 - 2000  
(Millions of Pounds)

Fiber Type	Year		
	1980	1990	2000
Graphite	2	27.6	71.6
Glass	880	1,200	2,000
Kevlar®	1.2	8	*
Silicon carbide whisker	0.002	1.5	*
Silicon carbide filament	0.0002	0.1	0.26

\*Insufficient information to make reasonable estimate.

**Table 2.** Projected Annual Production of Major Matrix Materials  
1980 - 2000  
(Billions of Pounds)

Resin Type	Year		
	1980	1990	2000
Polyester	1.1	1.6	2.4
Epoxy	0.065	0.13	0.25
Vinyl ester	0.021	0.030	0.05

to use. In the area of combustion, the Kevlar® fiber and the organic resins pose a potential problem and further research is required to assure that no hazard exists.

An analysis of the recycling options open to the composite materials investigated indicate that the most economically and environmentally viable recycling option would be burning for energy output. The fact that various kinds of fiber make up a major component of the feedstock complicates the combustion process. Graphite fibers should be contained because atmospheric release could result in electric problems in the vicinity of the incinerator. Glass fibers will present slag problems if they are melted in the incinerator. A summary of the ranking of the major materials studied follows:

	Use	Combustion
Graphite fiber	Group 1	Group 2
Glass Fiber	Group 1	Group 1
Silicon carbide fiber	Group 1	Group 1
Epoxy resin	Group 1	Group 3
Polyester resin	Group 1	Group 3
Vinyl ester resin	Group 1	Group 3
Kevlar® fiber	Group 1	Group 3

In summary, in almost all aspects of this study, no major hazard was identified. This holds true even though the relative amounts of composites are expected to grow dramatically, especially "advanced composites." It was recommended that the EPA continue its investigation into environmentally safe incineration technology applicable to composite materials.

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**The complete report, entitled "Assessment of Future Environmental Trends and Problems of Increased Use, Recycling, and Combustion of Fiber-Reinforced, Plastic and Metal Composite Materials," (Order No. PB 82-255 514; Cost: \$21.00, subject to change) will be available only from:**

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