EPA/742/F-95/015

EPA and the PWB Industry Team Up on Environmental Assessment of Technologies

By Deborah L. Boger

and Katherine M. Hart

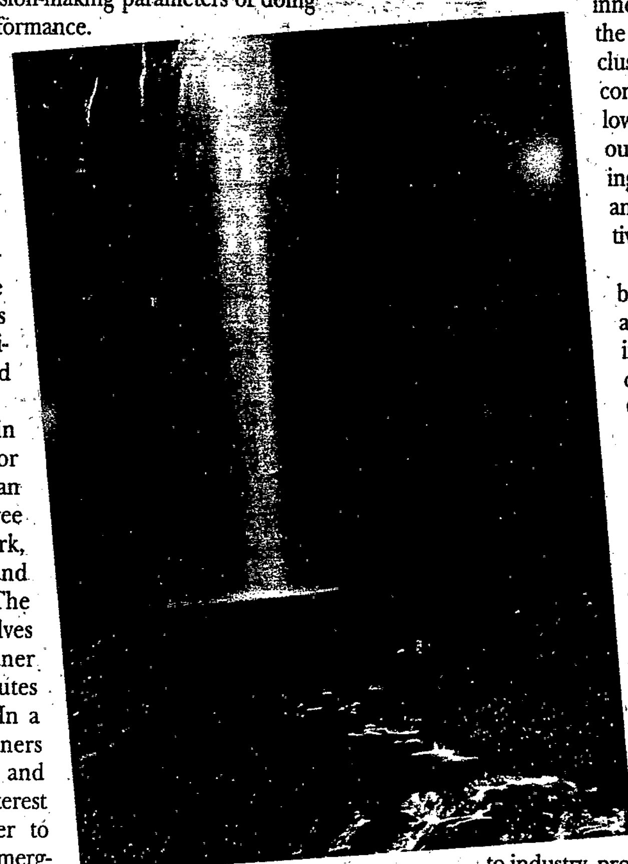
and Gary C. Roper

Through the EPA's Design for the Environment Program, EPA, industry and other partners can produce the information and tools needed to make environmentally informed choices.

Since when does the PWB manufacturing industry work with the U.S. Environmental Protection Agency (EPA) to do environmental and other evaluations of new technologies? Since EPA's Design for the Environment (DfE) Program began working with IPC, its member companies and other representatives of the industry on the DfE PWB Project, that is exactly what's been happening.

What is EPA's Design for the Environment Program?

The purpose of the Design for the Environment Program is to encourage business people to incorporate environmental considerations into what have traditionally been the sole decision-making parameters of doing business: cost and performance. One way EPA accomplishes this goal is by developing voluntary partnerships with particular industry sectors. Through these partnerships, EPA, industry and other partners produce the information and tools needed to make environmentally informed choices.



The work done in these industrial sector DfE projects typically can be categorized into three areas: technical work, communication and implementation. The technical work involves conducting a Cleaner Technology Substitutes Assessment (CTSA). In a CTSA, project partners (i.e., EPA, industry, and research and public interest groups) work together to evaluate existing and emerging technologies. Project participants collect and develop human health and environmental risk, cost and performance information about each of the technologies; the information is then laid out in a flexible format so that business decision-makers can assess trade-offs between alternatives. The information in the CTSA is communicated to industry and to the public, and EPA develops tools (such as training materials) to assist industry in implementing some of the new technologies. (For more background on the DfE program, see Circuitree, February 1995.)

DfE Printed Wiring Board Project Technical Work

History. In September 1994, EPA convened a DfE PWB Project Technical Workgroup kickoff meeting. Approximately 60 industry experts, EPA staff and university and public interest group representatives attended. At that meeting, workgroup members mapped out each step in the PWB manufacturing process. They then identified four functional areas as potential "use clusters" for evaluation in the PWB CTSA. A "use cluster" is a set of chemicals, processes or technologies that can substitute for one another in order to perform a specific function. For example, all of the different technologies/processes that can substitute for each other to etch inner layers would make up the "inner layer etching" use cluster. The four use clusters considered included the following: inner layer etching, outer layer etching and plating, hot air solder leveling and making holes conductive.

EPA and industry members collected information about the chemicals used in each of these four use clusters. EPA used the Use Cluster Scoring System, developed by its Office of Pollution Prevention and Toxics, to conduct a preliminary comparison of environmental and human health risks and pollution prevention potential associated with each cluster. Using the results of the scoring system and taking into account other considerations such as worker safety practices, regulatory burden and cost to industry, project participants chose the "making holes conductive" (MHC) use cluster as the focus of the CTSA. This selection was made in January 1995.

Technologies Being Evaluated

Once the use cluster for the CTSA was chosen, industry representatives identified alternative technologies used to accomplish the MHC function. These technologies are being evaluated in the CTSA, which is being conducted by the University of Tennessee's Center for Clean Products and Clean Technologies and reviewed by EPA. Criteria for including a technology for evaluation in the CTSA were that it must be an existing or emerging technology and that there must be equipment and facilities available to demonstrate its performance. Any supplier was free to submit a technology as long as it met the above criteria. The technologies identified for evaluation include the following: electroless copper, carbon, graphite, palladium, non-formaldehyde electroless copper, conductive ink and conductive polymer. Technologies that are not evaluated in the CTSA may be described qualitatively in a separate section of the document.

CTSA Components

The CTSA includes three principal types of information: human health and environmental risk, cost and performance. Environmental impacts other than chemical risk will also be assessed. The MHC CTSA will be a tool for industry decision-makers to use to assess trade-offs between different technologies that effectively make holes conductive. The document will not rank technologies, nor will it endorse one technology over another. Rather, it will characterize attributes of each technology so that businesses can decide which alternative makes sense for them in their particular situation. For example, a board shop in the southwest may find that it makes more sense to employ a product line with fewer water rinses because of water conservation considerations; a shop in the northeast may find it more economical and environmentally preferable to employ a product line that generates less sludge. A CTSA allows companies to decide what is best for them in light of comprehensive environmental information about each option.

Human Health and Environmental Risk

The MHC CTSA will include a characterization of the human health and environmental risk associated with each technology evaluated. In order to perform this risk characterization, EPA and the UT Center for Clean Products are working with suppliers of the industry to collect information about chemicals used in each technology. The hazard to human health (e.g., reproductive toxicity, developmental toxicity, carcinogenicity) and the environment (e.g., aquatic toxicity, bioaccumulation) posed by each of these chemicals is then assessed.

In addition, EPA and the UT Center for Clean Products are working with project participants and other representatives of the industry to collect information on worker and general population exposure to these chemicals and chemical emissions to the environment. Once all of the hazard and exposure data are collected, the UT Center for Clean Products will characterize the risks posed by each of the evaluated technologies.

Cost

The cost of operating each technology is also calculated in the CTSA. In order to make these calculations, EPA and the University of Tennessee worked extensively with suppliers and users of the technologies to identify factors involved in assessing purchasing and operating costs. Suppliers and users of each technology will provide detailed information on pricing, equipment maintenance, disposal requirements, bath life and water use to inform the cost evaluation. Much of the information used in the calculations will be derived from the performance demonstration described below.

The performance demonstration is an opportunity to collect information on cost, chemical exposure and natural resources use.

Performance

One of the most important aspects of any technology is how well it performs. The PWB Project is in the midst of conducting a "performance demonstration" to evaluate the performance of the technologies evaluated in the CTSA. The methodology for this performance demonstration was developed with extensive input from all project participant groups. It was designed simply to indicate characteristics of a technology's performance, not to define parameters of performance or to substitute for thorough on-site testing; it is intended to be a "snapshot" of the technologies. Because information will be collected from production facilities, the performance demonstration is also an opportunity to collect information on cost, chemical exposure, energy and natural resources use.

The general plan for the performance demonstration is to collect information about alternative technologies at sites where the technologies are already being used. The facilities that will be used as test sites were identified by suppliers of the technologies. The sites include production facilities, testing facilities (beta sites) and supplier testing facilities.

For the purposes of this performance demonstration, the MHC process is defined as everything from (and including) the desmear step to (and including) 0.1 mil of flash plating. In order to minimize differences in performance due to processes outside this defined MHC function, the panels (100 18" x 24" 8-layer multilayer panels) used for testing will all be manufactured and drilled at one facility. From there, three panels will be shipped to each testing site to be processed through the site's MHC line. An on-site observer will be present at each processing site to record data such as bath operating temperatures, cycle time, room ventilation, rack cleaning methods, frequency of bath additions and annual pounds of sludge generated. This information will be incorporated into the CTSA.

After the panels at each demonstration site have been processed (up to 0.1 mil flash), they will be shipped to a single facility where they will be electroplated up to 1.0 mil of copper. Coupons will be routed and sent for electrical and mechanical testing.

Electrical testing will be done using the Interconnect Stress Test (IST), developed by Digital Equipment of Canada Ltd. The IST is an accelerated method for testing the failure modes of printed wiring board interconnects. IST creates the required temperatures electrically within the interconnect, while other methods create required temperatures externally. Traditional mechanical testing (IPC Standard RB 276) will also be conducted on standard AT&T B coupons. In addition, there will be remaining coupons so it will be possible to carry out further tests in the future should anyone wish to do so.

The level of commitment and participation on the part of IPC members and the industry in support of this project has been very high from the outset. Participants in the performance demonstration have been particularly involved in lending technical expertise and direction for a successful evaluation of the technologies. Suppliers that have submitted technologies for evaluation in the performance demonstration include Atotech USA; Electrochemicals Inc.; Enthone-OMI Inc.; LeaRonal Inc.; MacDermid Inc.; Shipley Co.; Solution Technology Systems; and W.R. Grace & Co. Each of these suppliers has submitted names of production facilities at which they would like their product lines tested.

In addition, a number of companies have volunteered their time and resources to take part in completing the performance demonstration. H-R Industries Inc. will manufacture and drill the panels using core materials donated by ADI/Isola. Hadco Corp. will electroplate the panels once they have been processed through the MHC lines and rout the coupons. DEC Canada has volunteered an IST machine for electrical testing, and the technical workgroup is still looking for an independent laboratory to conduct mechanical testing.

The performance demonstration workgroup also has coordinated its efforts with other industry groups involved in evaluating PWB technologies. At the IPC Expo in San Diego last May, DfE performance demonstration workgroup participants met with IPC's Plated Through Via (PTV) Subcommittee to discuss the DfE performance demonstration. The PTV Subcommittee is conducting a round-robin test of board testing methods, and the IST technology is one test method involved in that round-robin. The artwork and detailed characteristics of the panels in the DfE performance demonstration are a slight variation of the artwork and characteristics used in IPC's round-robin testing. The PTV Subcommittee also plans to do some sort of evaluation of the emerging direct metallization technologies; however, they are waiting for the results of the DfE performance demonstration to direct their efforts in this area.

Looking Ahead

Because of the current interest in technologies to make holes conductive and the number of new technologies available for use, the DfE PWB Project hopes to complete its evaluation of these technologies within a short time frame. The performance demonstration site visits are expected to be near completion by the end of September 1995, and the electroplating of the boards will take place soon after that. The electrical testing may extend to early 1996. Information from the performance demonstration will be integrated into the CTSA, a draft of which is expected by late 1996.

The next DfE PWB Project meeting will be held in Providence, Rhode Island, 30 October 1995, in conjunction with IPC's fall meeting. By this date, a number of project documents, such as the PWB Industry and Use Cluster Profile, the Printed Wiring Board Pollution Prevention and Control Survey, and the Federal Environmental Regulations Potentially Affecting the Computer Industry will be available. In addition, a project fact sheet and two pollution prevention case studies are now available.

For More Information

The DfE PWB Project team encourages all interested parties to participate in the project, either by joining the Technical or Communication Workgroups, by attending project meetings, or by asking that EPA include them on the project mailing list. For more information about the DfE Program or the DfE PWB Project, to obtain copies of documents mentioned in this article, or to be added to the mailing list, contact EPA's Pollution Prevention Information Clearinghouse (PPIC), U.S. Environmental Protection Agency, 401 M St., S.W. (3404), Washington, D.C., 20460. C

Deborah L. Boger and Katherine M. Hart are Environmental Protection Specialists with EPA's Design for the Environment Staff (Washington, D.C.). Gary C. Roper is vice president of process engineering at H-R Industries Inc., Richardson, Texas, and is a member of the IPC Environmental, Health & Safety (EHS) Steering Committee.