PROPOSALS FOR SEMATECH

March 24, 1993

PROMOTE ENVIRONMENTALLY SUSTAINABLE MANUFACTURING IN THE SEMICONDUCTOR INDUSTRY

The manufacture of silicon chips is dependant on the use of many toxic gases, solvents, etchants, heavy metals and volatile organic compounds. New techniques are needed to make chips without threatening the environment or endangering production workers and others who may come in contact with hazardous materials.

SEMATECH's environmental research role should be as a leader in replacing process chemicals such as CFCs and other chlorinated solvents, and glycol ethers used in photoresists. The consortium should seek safe substitutes for these chemicals--free of carcinogenic, reproductive, and neurotoxic effect. It should also demonstrate to industry members and their suppliers how to replace acutely toxic dopant gases that are now an integral part of chip production. SEMATECH should explore new methods of lithography and other production techniques that require fewer chemicals at the outset and show member companies how to adapt these technologies.

Some specific task force recommendations include:

1. A Life Cycle Analysis of the Semiconductor Manufacturing Process.

Life Cycle Analysis (LCA) is an analytical technique pioneered in the packaging and consumer product industries for assessing the environmental burden of a product throughout its life cycle from synthesis and manufacture through use to disposal. No such analysis has been attempted on semiconductors. LCA studies are now being promoted in the Netherlands, Denmark, and other Scandinavian countries to assess the full environmental and health impacts of differing products and production operations in several industries, especially pulp and paper.

SEMATECH should develop a LCA approach for semiconductors, identifying those steps in the life cycle that generate pollution, consume resources (energy and water), and endanger public or occupational health. The LCA should include an assessment of toxics use reduction opportunities, materials and waste audits, and mass balance materials accounting. The LCA should also include an assessment of internalizing the costs of disposal and the guaranteed return and safe disposal of all used products. SEMATECH should take the lead in designing new products and processes based on this life cycle perspective.

2. A Program for the Substitution of the Glycol Ethers in Production Operations by 1994.

Glycol ethers have been the subject of occupational and environmental health concerns for over 20 years. The original "clean room" health studies carried out by Digital Equipment Corporation, as well as the recent IBM and Semiconductor Industry Association studies, have all identified the ethylene-based glycol ethers (diethylene glycol dimethyl ether, ethylene glycol mono-ethyl ether acetate, etc.) as reproductive toxins. While propylene glycol ethers are frequently identified as a more benign substitute for the ethylene-based glycol ethers, there is growing concern about the reproductive toxicity of these potential substitutes as well.

SEMATECH should develop an aggressive program to identify and promote safe material substitutes or alternative production processes that would effectively eliminate the use of all glycol ethers in the semiconductor

industry by 1994. SEMATECH should also support a follow-up industry-wide health survey to focus on birth outcomes to supplement the miscarriage studies recently completed.

3. A Program for the Substitution of Acutely Toxic Gases in Production Operations by 1996.

The use of arsine, phosphine, diborane and other acutely toxic gases as dopants in the production process presents unique hazards in terms of long-term health impacts and immediate acute risks. These gases has prompted significant concerns from employees and nearby communities. Safer alternatives to some of these gases are currently available at competitive prices. However limited knowledge, and the costs of conversion appear to be the primary barriers to wider adoption of alternatives.

The growing demand for gallium arsenide chips also increases the potential for serious health and environmental risks in semiconductor production.

SEMATECH should identify the substitute chemicals and alternative production processes available, and assist member companies to overcome conversion barriers in order to eliminate the use of dopant gases in the semiconductor industry by 1996.

4. A Program for the Substitution of all Ozone Depleting Chemicals by 1995.

The Copenhagen meeting of the Montreal Protocol reaffirmed the international commitment to eliminate the production and use of the most ozone depleting chemicals by the end of the decade. The United States has set a target of 1996 for the elimination of all Class A ozone depleting chemicals (including CFC-11, -12, -113, and -114, carbon tetrachloride, halons and methyl chloroform). In the regions of the country where the electronics industry is concentrated, this one industry generates the largest releases of ozone depleting chemicals.

SEMATECH should develop and promote an aggressive program to eliminate the use of all Class A ozone depleting chemicals from the semiconductor industry by 1995 and all Class B chemicals by 1997.

5. Establish a "Safe Substitutes" Policy

In order to avoid making costly mistakes by substituting one problem chemical for another, SEMATECH should consult with the National Toxicology Program to develop a "safe substitutes" guidance policy for its member companies. Such a policy would provide that no materials be introduced into the production processes:

a) if studies indicate potential reproductive harm or other chronic health effects; or
b) unless studies have indicated that a material is safe and does not cause reproductive harm or other chronic health effects.

6. A Program that Reduces the Release of all Toxic Chemicals from Production Facilities by the year 2000.

The release of persistent, bio-accumulative and toxic chemicals to the environment in the form of wastes is both a source of environmental and public health stress--as well as evidence of materials inefficiencies in production. For instance, the National Toxics Release Inventory accounts for a total of 2.8 million pounds of glycol ethers

released to the environment from the semiconductor industry (SIC 3674) between 1987 and 1990. In 1990, the federal Environmental Protection Agency called upon American industry to reduce by half the release of 17 targeted toxic chemicals by 1995. Several SEMATECH members companies have joined the 33/50 program, some have not. While over 400 corporations have voluntarily committed to this goal, many firms have gone even further. The Monsanto Corporation, for example, has announced a goal of zero emissions by the year 2000.

SEMATECH should develop and promote a program that guides firms to achieve zero emissions of all persistent, bio-accumulative and toxic chemicals by the year 2000. It should also keep track of member company progress in reducing emissions, on a facility by facility basis.

7. A Program for Recycling and Reuse of Semiconductor Chips.

Conventional practice dictates that many semiconductor chips, and related components, are converted to solid waste once the product containing them is disposed. Even where the useful life of the product may be over, the chips may be redeemable for reuse or recycled to retrieve valuable materials that may otherwise enter the environment as hazardous pollutants. Many industries are now exploring the benefits of reuse and recycling used products. The German government is developing programs requiring the "take back" of all packaging and certain products manufactured by domestic firms. Several U.S. electronics firms such as Digital Equipment Corporation are piloting "take back" and recycling programs for computers. Early experiences suggest that these programs are greatly enhanced where reuse and recycling potential was "designed in" to the product at its point of manufacture.

SEMATECH should develop and promote take back, reuse and recycling programs for semiconductors to eliminate the disposal of semiconductors as solid waste. It should also "design in" re-use and recycling potential as it develops new chip research and development.

8. An Exploration of the Environmental and Health and Safety Impacts of Conversion to Additive Production Technologies.

Conventional production technologies for the manufacture of semiconductors rely on a series of plating and etching steps called subtractive technologies. These processes inherently create wastes in the form of the material that is removed following each etching step. A completely different approach would add to semiconductor wafers only that material that is desired and eliminate the subtractive operations. It is projected that these additive technologies would dramatically reduce waste and increase the efficiency of precious material use.

SEMATECH should prepare an analysis of the possibilities and benefits of converting to additive technologies and provide policy recommendations to government and industry to promote these technologies.

9. An Exploration of Biological and Renewable Material Foundations for Converting Semiconductor Production to Less Toxic Materials.

The reduction in the use of toxic chemicals in production is enhanced where less toxic and more environmentally sound materials are readily available and cost competitive. Toxic chemicals frequently dominate in particular functions because little research has been conducted to identify safe substitute materials developed from different