Roundtable Meeting with Stakeholders

Reducing Environmental Impact by Half at Semiconductor Factories

—How can semiconductor-related companies best collaborate to achieve total optimality?

Reducing the impact of the chip-making process on the environment is an industry-wide issue for the semiconductor sector, as the process involves massive use of electricity, chemical substances and other resources. We held a roundtable meeting on July 1, 2008 to discuss necessary collaboration and cooperation in order to reduce the environmental impact at semiconductor factories by half, inviting representatives from semiconductor manufacturers, relevant equipment and component manufacturers and a company that designs and constructs clean rooms.

Invited Participants in the Roundtable Meeting

Intel Corporation	Mr. Hidetoshi Sakura
Samsung Electronics	Dr. Tae-Jin Park
Toshiba Corporation Semiconductor Company	Dr. Yuichi Mikata
Edwards Japan Limited	Mr. Chiaki Urano
Ebara Corporation	Mr. Nobuharu Noji
Taisei Corporation	Mr. Tomoo Gocho

Environmental Activities within the Semiconductor Industry: Progresses to Date and Future Challenges

Saito (TEL): The Tokyo Electron Group plans to achieve a 35% reduction in energy use per unit area of wafer from the 1999 level by 2010, in line with the policy of ITRS[1]. We set this reduction target as we believe that reducing the environmental impact of every single process in semiconductor manufacturing is an industry-wide responsibility. ITRS recently released an additional Roadmap which calls for a 50% reduction of the total fab energy use during the 2016-2022 period from the 2007 levels. The semiconductor industry needs to take collective action to meet this target.

Meanwhile, to address the degrading environment, every member of the semiconductor industry, from upstream to downstream, needs to intensify their environmental efforts by setting additional targets in areas not covered by the SEMI S23[2], such as waste, chemical substances and recycling.

1 **ITRS:** International Technology Roadmap for Semiconductors, an organization of the semiconductor industry which sets industry-wide targets on technologies, environment and other applicable elements.

2 **SEMI S23:** Guidelines for energy conservation for semiconductor production equipment issued by the Semiconductor Equipment and Materials International (SEMI), an international industry organization for semiconductor/FPD production equipment and material manufacturers.

Sakura: At Intel, we have a system in place to produce products with a lower environmental impact. When developing a new manufacturing process, we develop guidelines covering relevant matters, such as energy efficiency improvement, restriction on the use of chemical substances and occupational safety with reference to relevant guidelines like SEMI, RoHS, and EICC.[3]

Our energy consumption target during the period from 2002 to 2010 aims at an average 4% annual reduction per production unit. We have achieved a total 20% reduction over the past five years. As the next step, we are working toward a long-term goal of reducing electricity consumption using guidelines such as SEMI S23 in our use of relevant equipment. We have also asked our suppliers to present their roadmaps to work together for this purpose.

3 **EICC:** The Electric Industry Code of Conduct, guidelines for responsible supply chain management

Park: In the Seoul metropolitan area, regulations on the emissions of CO_2, NOx, SOx and other applicable substances have been changed from a concentration base to a total emission base. A 50% reduction of these emissions from the 2001 levels is also required. To meet these new requirements, our factories are analyzing the substances captured by gas scrubbers and taking necessary actions. We have accomplished a high level of energy conservation in our operations, thanks to support from the semiconductor manufacturer.

Mikata: Reducing CO_2 emissions directly means reducing electricity costs. This is a powerful motivation for us at Toshiba to lower emissions. Over the past four years, we have slashed our per unit area electricity use of new facilities by half compared to 200-millimeter wafers. A shift to the use of 300-milimeter wafers was the major reason for reinforcing our reduction efforts, which, in turn, led us to reduce consumption per basic unit. As a result, we have successfully limited the increase of CO_2 emissions for the past three to four years, despite the fact that our productivity has increased during the period.

Current Environmental Cooperation among Firms related to Semiconductor Manufacturing

Mikata: Toshiba started the Clean Room Econology[4] Project with production equipment manufacturers and facility engineers from 2004. In this trilateral initiative led by Toshiba's production manager, working groups (on power facilities, manufacturing equipment, etc.) discuss and explore the optimal specifications of relevant facilities. The project has helped us reduce energy loss and generate technological innovation as well as new ideas to improve energy efficiency.

4 **Econology:** A word coined from "ecology," "technology" and "economy."

Park: I agree with the necessity of such trilateral consultation in the development phase. In a new semiconductor manufacturing process, for example, the temperatures and pressures involved would be different from conventional ones, which means that the types of gases required and the conditions of chemical substances would also be different. However, we do not usually have access to detailed information not included in the MSDS[5]. We thus seek necessary supplemental information from equipment manufacturers.

5 **MSDS:** Material Safety Data Sheet

Urano: While semiconductor manufacturers develop roadmaps for reducing CO_2 emissions and taking other environmental steps, the most important element in the next phase is which specific actions are to be taken along with the roadmaps. Therefore, it is essential to examine every element (equipment, component, etc.) of the chip-making process. We, as a supplier of exhaust systems, are doing our part by working to improve energy efficiency of our component products. If we can obtain related information, such as equipment locations and the distance from a gas scrubber and dry pumps, we will be able to suggest more concrete, useful ideas.

Sakura: At Intel, we meet equipment manufacturers regularly to share information on new technologies at a very early stage.

Cooperation in the Future

Urano: Semiconductor manufacturers and equipment manufacturers should always work closely with one another in developing the manufacturing process. Energy use can be reduced by simple improvements such as installing pipes of optimal length and treating gases closer to the manufacturing equipment. Full consideration of the layout of the entire clean room may lead to smaller and thus cheaper dry pumps.

Park: Such discussion for improvement is much needed. We revised our manufacturing process three times in the past but did not witness any effective collaboration among the related parties. The three parties involved—the facility and equipment manufacturers and our company—require an occasion to coordinate their respective actions, rather than implementing them individually. Discussing and agreeing on a policy to reduce energy consumption would generate much greater benefits. To this end, we need to invest time for in-depth discussions.

Mikata: Improving productivity is a very effective measure to reduce CO_2 emissions. Enhanced processing capabilities per unit hour or higher utilization of equipment means that the same number of facilities produces a greater number of semiconductors, which indicates reduced electricity consumption and CO_2 emissions.

Cutting back on standby power consumption is another challenge. Most equipment, barring lithography equipment, is not necessarily used all the time throughout the entire wafer processing operation. Standby electricity may account for 20 to 30% of overall power consumption depending on the size of fab, and we hope a power-saving function, just like “sleep mode” for PCs, will be made available. It should start with standardizing the specifications of sleep mode.

Ibuka (TEL): I agree. A sleep mode needs to be redefined by SEMI Standards or their equivalents.

Noji: Speaking of reducing power consumption, Ebara is a pioneer in energy-efficient pumps and has been providing pumps powered by variable-speed motors since 1995. These pumps enable the setting of a sleep mode. In reality, however, some equipment manufacturers are reluctant to install the pumps, partly due to the implications on the yield rate and manufacturing process.

However, over a decade of operation, our dry pumps with variable-speed motors consume 80% less energy. Future improvement of processing technology for pump components will achieve greater energy efficiency of the pumps alone. We need to seek comprehensive solutions that combine improved performance of individual equipment and a reduction in standby power consumption.

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Ishida (TEL): To attain higher productivity, minimizing defects is the key. More active communications and cooperation among semiconductor manufacturers, equipment manufacturers and material manufacturers with regard to the number of required processes and the costs of respective processes will bring about reductions in the number of defective products.

While I understand some information is subject to confidentiality restrictions, I still believe collaboration among the relevant companies is indispensable in developing next-generation devices.

Araki (TEL): How about designing overall factory layout? Some cases show simply changing the pump location or pipe length has led to higher productivity by 5 to 10%.

Gocho: As a construction company, we focus primarily on providing sturdy, long-lasting buildings in earthquake-prone Japan. Using the same approach, we are working on comprehensive measures to protect clean rooms from quake-related damage such as through the development of seismic control and isolation technologies. Having said that, when we actually construct a semiconductor factory, it is very difficult for us to do anything more than design details of the factory in line with the grand design, as the time from the obtainment of the grand design on the occasion of bidding to the launch of construction is generally quite short.

We wish to be involved from the planning phase, where possible. We currently find it difficult to take the initiative and propose ideas. We of course intend to undertake further study on the relevant equipment, which is still an unknown quantity for us.

Necessity of Both Individual Cooperative Action and Collective Standardization

Yamanaka (TEL): It is true that certain elements can be standardized through discussions among relevant trade associations. On the other hand, one-on-one discussions may not always bring progress as the discussing parties may or may not acquire the contract, or the relevant contract may or may not be determined by bidding.

Ibuka (TEL): Discussions among relevant industry organizations, such as SEMI, Semiconductor Equipment Association of Japan (SEAJ) and the Japan Electronics and Information Technology Industries Association (JEITA), sometimes lead to solutions. We in the same industry can discuss, share information and cooperate with one another, where needed, to the extent that confidentiality issues do not arise.

Ishida (TEL): When it comes to cooperation, it would be sensible for semiconductor manufacturers to take the lead.

Mikata: I think effective cooperation takes place when relevant parties — the semiconductor manufacturer, the equipment manufacturer and the construction company — exchange relevant information and insights to eliminate inefficiencies at each relevant process in the entire project.

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At the same time, standardization efforts that have the participation of all relevant parties are also very important. In developing the SEMI S23, the aim was to create a standard that can facilitate lower energy consumption. To this end, a unified coefficient was established and demands from both equipment and semiconductor manufacturers were accommodated to the greatest extent possible. The crux is that we need to forge collaborative working relationships among related parties by aligning interfaces and identifying what should be done independently and what should be done through collaboration. Both individual collaborative efforts and collective standardizing processes are important.

Ishida (TEL): Exactly. We at TEL have long studied the SEMI Standards, through which we have played an important role in addressing environmental issues and improving productivity. Without such unified standards, different manufacturers would have developed different product specifications, entailing unnecessary costs and substantial waste of resources.

Mikata: SEMI S23 is an example of standardization that is beneficial and user-friendly. By applying the energy coefficients defined by this standard, you can quantify your energy use at every process across the product lifecycle. The resulting numerical data presents a clear picture of which process is the most energy intensive and which process has room for improvement.

Such standardized coefficients cannot be determined without the involvement of semiconductor, equipment and facility manufacturers. Again, collaboration is the key here.

Hoshi (TEL): SEMI S23 has made our life easier as its coefficients allow us to track various energy consumption data centrally. We will be able to develop equipment that can reduce the environmental impact of facilities if our product developers learn more about the facilities, such as the different coefficients applied to low-temperature cooling water and to high-temperature water resources.

Ibuka (TEL): Given the magnitude of the social demand for environmental solutions, we need to establish and achieve ambitious goals; otherwise public trust in the entire semiconductor industry may be eroded. Together, we intend to work closely toward total optimality.

Saito (TEL): Today's discussion led me to think we can still eliminate inefficiencies in clean rooms simply by sharing information in a timely manner, among other factors. With support and insights from various stakeholders, including customers, related device manufacturers and construction companies, we intend to achieve further reductions in the environmental impact of our products and semiconductor factories.

Following the roundtable meeting …

In this year's roundtable meeting for our environmental and social report, we invited our customers, manufacturers of semiconductor production equipment components and a construction company that designs and constructs clean rooms to participate, as we did for the last year's publication. We are delighted to have had a constructive and fruitful discussion, which clearly indicated an overall direction for future activities.

At the conference of the International Semiconductor Environment, Safety & Health (ISESH) held in Sapporo on June 23, 2008, our Chairman, Tetsuro Higashi emphasized in his keynote speech that the semiconductor industry needs to take collective action in earnest to address environmental issues, particularly global warming, and that industry organizations such as SEMI, International SEMATECH Manufacturing Initiative (ISMI), JEITA and SEAJ need to take initiatives to promote industry-wide efforts. He also declared that the Tokyo Electron Group will operate its business with particular focus on innovation, growth and the environment.

While this roundtable meeting was truly meaningful, solving environmental issues requires more than a single company or country's initiatives but worldwide efforts. I am convinced that in light of this enormous global challenge, corporate social responsibility (CSR) will become of even greater importance for corporations, whether they are large or small.

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