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Title

The Environmental Value Systems Analysis - Research Report for 2002

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The Environmental Value Systems Analysis – Research Report for 2002

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1. The EnV-S Analysis

Equipment and semiconductor manufacturers need a tool for the quantitative evaluation and comparison of tool centric environmental solutions. The Environmental Value Systems (EnV-S) Analysis was developed at UC Berkeley in collaboration with Applied Materials to address this need. The EnV-S Analysis Framework appears in Figure 1.

The blueprint for the EnV-S analysis is catered towards addressing the needs of manufacturers and suppliers and overcoming the challenges therein. Some of the salient features of the EnV-S are listed in section 1.1.

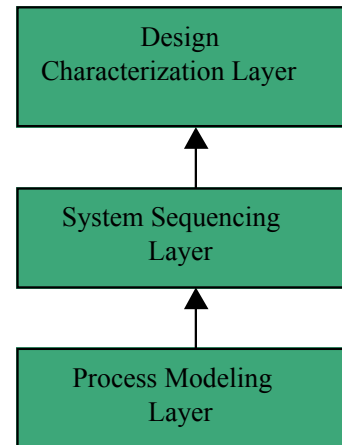


Figure 1. The EnV-S Framework.

1.1 EnV-S Model Blueprint

- Focus the model on the process tool and the support equipment.
- Ensure the model output is in terms of important business metrics such as CoO.
- Factor in all controllable variables that significantly affect the key outputs.
- Provide sensitivity analysis for those controllable variables.
- Enable “what-if” comparisons between various solutions.
- Make the tool suitable for the casual user (i.e., user-friendly).
- Use industry norms for cost/performance parameters (e.g., UPW costs)
- Make the tool readily available and, if possible, an industry standard.

2. Significant Accomplishments (Year 2002)

- The environmental value systems analysis (EnV-S) methodology has been applied to low-K dielectric materials and processes, including both spin-casting and plasma-enhanced CVD approaches. Low-K dielectrics will have a pervasive influence on the technology for years to come, and they raise critical issues for ESH. In addition there has been continuing work on CMP, PFC abatement, and human health issues.

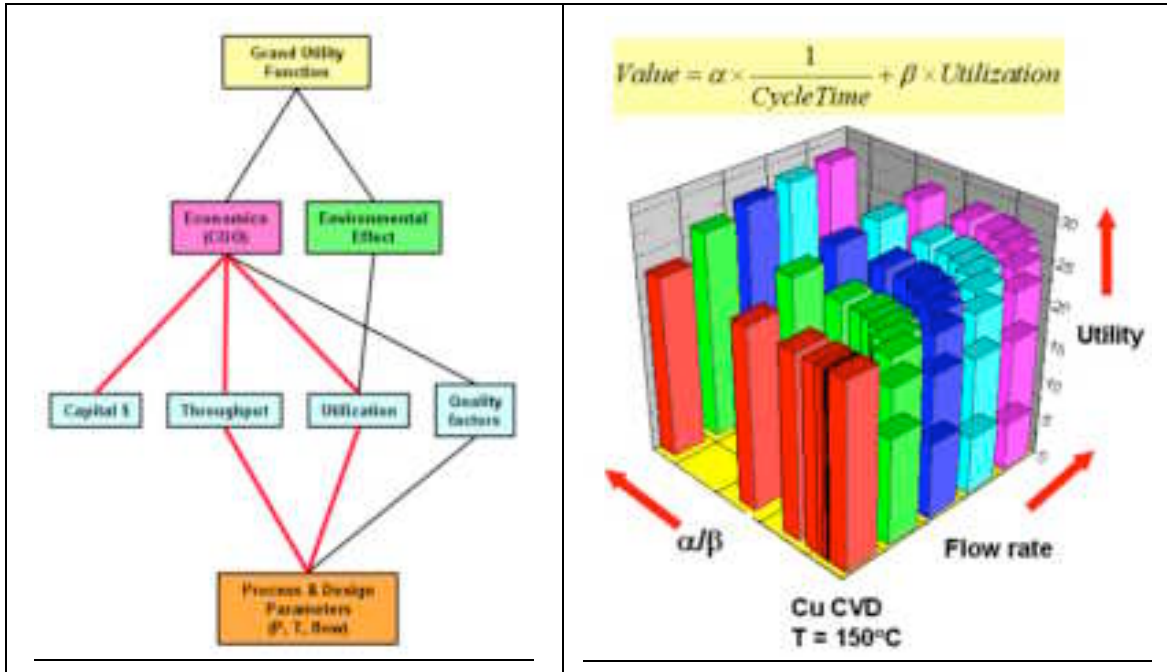


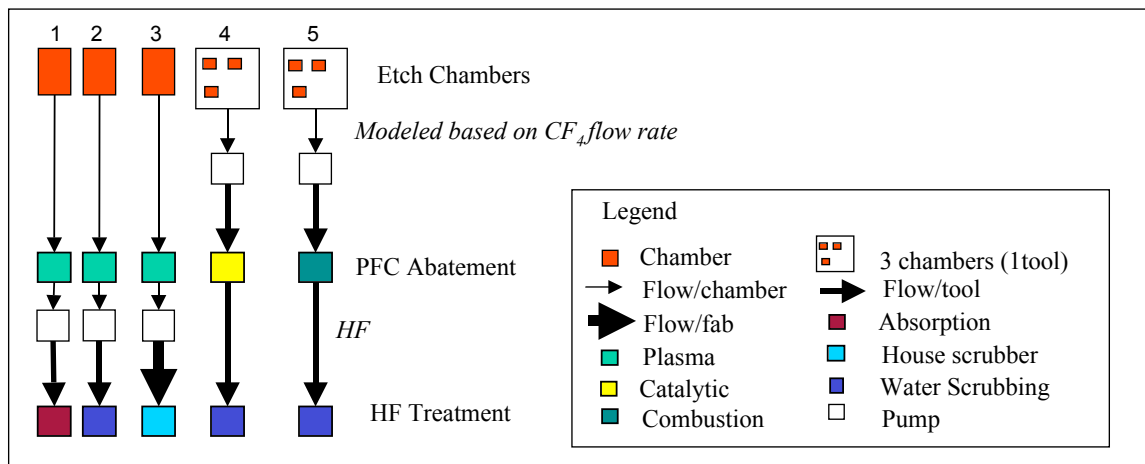
Figure 2. Relationship between unit process parameters and higher level metrics, both economic and non-economic, with Cu CVD unit process example.

- b. EnV-S has generated significant industry interest. A workshop/teleconference was held during SEMICON West, which presented the approach, capabilities, and plans for transfer to industry.
- c. An alpha version of an automated EnV-S system has been constructed using Visual Basic with the help of undergraduate REU students. Continuing work, also involving REU students, on improving the data handling capabilities of the EnV-S is in progress
- d. The Multi-Criteria Hazard Analysis for Human Health Characterization has been modified, with the help of REU students, to enhance the ability to characterize health hazards in spite of data gaps which are often a problem with semiconductor process chemicals.
- e. Results of continuing work on PFC abatement have been presented at SEMICON West. Results from the analysis, specifically addressing the problem of how best to design the ESH infrastructure for accomplishing this task at the factory level, are shown in Figures 2 and 3. Such analyses are crucial in the substantial challenge posed by ESH infrastructure.

3. Publications

- Krishnan, N. Woolston, M., Dornfeld, D., “Exploring Environmental Cost of Ownership of Perfluorocarbon (PFC) Abatement Options and Decision Spaces using the Environmental Value Systems (EnV-S) Analysis,” *Environmental Technologies and Manufacturing Practices*, SEMICON West 2002.
- Dawn Speranza and Uday Ayyagari, “Environment, Health, and Safety (ESH) Cost of Ownership of Spin on Dielectric (SOD) Low-k vs. Chemical Vapor Deposition (CVD) Low-k”, *SEMATECH Technology Transfer*.

Options space - Different combinations of abatement and downstream options



Abatement option space for PFC destruct from Etch tools

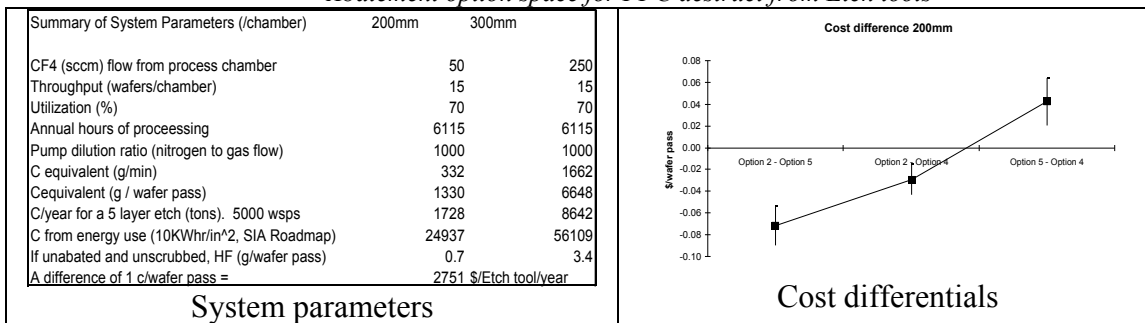


Figure 3. EnV-S analysis for various factory infrastructure approaches to PFC abatement.

Research Plans for 2003

a) Continue the development of EnV-S for industrial applications with primarily ease-of-use and economic CoO in mind. Further develop ESH CoO components, such as detailed costing of personal protective equipment requirements, cost of engineering controls, facilities infrastructure, etc.

b) Complete the EnV-S analysis of low-K dielectric options (spin-casting and PECVD), and begin development of EnV-S libraries for different modules and process platforms for manufacturing (e.g. for STI, interconnect, etc.) using EnV-S models for individual platforms such as the AMAT producer, centura and models for facility level abatement systems.

c) Continue the development of environmental (non-economic) aspects of EnV-S, with particular regard to interests of community stakeholders outside the company.

d) Link EnV-S analysis within the facility to different life cycle tools and methods for evaluation of upstream and downstream impacts. Preliminary results from using economic input output methods appear promising.