Manufacturing Science and Technology Group
Room 611 - Session MS-TuM

New Manufacturing Research Paradigms

Moderator: C.B. Whitman, CVC Products Inc.

8:20am **MS-TuM1 Proposal of New Paradigm LSI Structures and Their Manufacturing***, **T. Ohmi**, M. Hirayama, Y. Shirai,* Tohoku University, Japan **INVITED**

UCS (Ultra Clean Society) was established in October, 1988 and is going to finish its mission at the end of September, 2000. For these 11 years, UCS has developed many new technologies mainly focussing on an improvement of process quality by removing unknown factors from manufacturing such as contaminants (particles, metals, organic molecules, moisture molecules, native oxides, surface micro-roughness, electrostatic charge-up and etc.) and fluctuations of process parameters giving an influence on process results. Consequently, semiconductor processes can be understood in a scientific manner, resulting in an improvement of process reproducibility. Developments of very well regulated high density plasma source for RIE, sputtering and plasma CVD, and room temperature 4 steps substrate surface cleaning have drastically improved process quality and process reproducibility. Equipment individuality has been overcame by introducing RF circuit specification to the process chamber and very well regulated process gas supply to the wafer surface by newly developed Flow Control System, so that so that process recipe can be applied to all other identical process chambers resulting in a complete process reproducibility and a low price process equipment. Right now, very high throughput and very compact manufacturing line must be established having a capability of simplified process steps, very low consumption volume of electricity and resource materials down to 1/10. Complete process reproducibility will make it true the computer simulation of all processes by microprocessors. Process flow and process conditions will be derived by computer simulation just after the completion of LSI design. Manufacturing of newly designed LSI will start immediately without using pilot wafers. Very low cost and very QTAT manufacturing are crucial for coming networked digital home electronics era. New society will focus on these issues.

9:00am **MS-TuM3 The IC Interconnect Millenium Transitions; Al to Cu, SiO@sub 2@ to Low-K***, **K.A. Monnig**, A.C. Diebold,* SEMATECH **INVITED**

This paper will give a general overview of the transitions occurring in I.C. interconnect systems today; Al conductors with SiO@sub 2@ insulators are planned to be supplanted by Cu metal with Low-K dielectrics. The reasons why this transition is happening now will be outlined. Almost all of the fabrication processes used will be changed and these differences will be reviewed. Special attention will be given to vacuum processing applications that will be lost due to the changes and to the new opportunities created. An assessment of financial and technical risks will be shown. Finally a current status report on the progress of the various transitions will be presented.

9:40am **MS-TuM5 Cooperative University Research for Critical Front End IC Processes***, **J.R. Hauser**,* North Carolina State University **INVITED**

MOS device physics and technology are rapidly approaching some fundamental limits as device dimensions are scaled below 100 nm. Fundamental tunneling limits to SiO2 gate oxide are approaching as oxide thickness scales below 2 nm. Low resistance source/drain contacts are becoming increasingly difficult as junction depths decrease and required doping densities approach or exceed solid solubility limits. In order to address these issues, a new cooperative research center was established in 1998, the SRC/SEMATECH Front End Processes Research Center. The Center seeks to bring together research in three areas: (a) Fundamental materials and interface physics and chemistry, (b) Process integration and demonstration and (c) Rapid transfer of technology to industry and equipment companies. To effectively integrate such research efforts, requires new paradigms for cooperative university research and this presentation will discuss how this is being approached within the SRC/SEMATECH Research Center.

10:20am **MS-TuM7 Industrial-Academic-Government Partnerships; A Successful Example***, **J.B. Bindell**,* Cirent Semiconductor (Lucent Technologies) **INVITED**

Semiconductor manufacturers have always had a close relationship to Universities, using them for purposes ranging from professional training to contract research and development. These relationships have also been synergistic, with the Universities strongly benefiting from in depth relationships with high technology firms. These reverse benefits have also been multifaceted, with funding, training delivery opportunities and contact with well known industrial scientists yielding many productive interactions. When Lucent Technologies located its leading edge manufacturing facility in Orlando, Florida, and then moved a major Bell Labs R&D division to the same facility, a number of interactions were suddenly spawned. Three distinct players were involved. These were Lucent, which found itself in need of strong University support, the University of Central Florida (UCF) and the University of South Florida (USF), both relatively close neighbors, and the state of Florida itself which had designated an extended area between Orlando and Tampa as the "Florida High Tech Corridor". The corridor's establishment was an important part of a desire to make this region a magnet for additional semiconductor manufacturers and for the economic growth that would surely follow. This three-way partnership between industry, government and education has led to a new paradigm for such interactions in which the boundary between our industrial laboratory and those of the Universities has become unclear. In fact, in the disciplines where Lucent has needed University support, these partnerships have created resources which are well on their way to national prominence. This presentation will center on the University programs and facilities that have developed from this partnership as well as on the issues of industrial involvement in the area of workforce development.

11:00am **MS-TuM9 Cooperative Research on Environmentally Benign Semiconductor Manufacturing***, **F. Shadman**,* NSF/SRC Engineering Research Center **INVITED**

This presentation will be an overview of the multi-disciplinary research program at the NSF/SRC Engineering Research Center involving a team of researchers from six universities. The Center is focusing on a dual approach to the environmentally benign semiconductor manufacturing. The first approach involves the development of novel processes where environmental, safety, and health (ESH) factors are among the primary design parameters together with performance and cost. The second approach focuses on improving the existing processes for ESH gain. Several examples of the thrust areas and projects of the Center will be discussed. In particular, the following topics will be covered in depth: Reduction of water and chemical usage for surface preparation and wafer cleaning; Environmental gains in the development of new low-k materials/processes as well as the new etch and deposition methods; Waste reduction and recycling in the CMP process; Energy use reduction through novel purification processes; Application of simulation and integrated modeling for recycle and reuse optimization in selected fab processes. Finally, the educational program of the Center that focuses on including the ESH subject in the core engineering curriculum will be discussed briefly.

11:40am **MS-TuM11 EquiPSim: Hands-On Training in Semiconductor Equipment and Process Behavior***, A.R. Rose, **G.W. Rubloff**, N. Kositsyna, N. Gupta, R. Sreenivasan, W.S. Levine,* University of Maryland

We have developed EquiPSim (Equipment and Process Simulation), a software-based learning system for semiconductor manufacturing aimed at providing active hands-on experience in the equipment and process environment of semiconductor manufacturing. Physically-based dynamic simulators, validated against experiment, were constructed on a commercial PC-based simulation software platform (VisSim@super TM@ v/3) and linked to a graphical user interface built on a Delphi@super TM@ v/4 visual development platform. As the learner operates the controls (actuators such as valves, settings, etc.) on the equipment or changes system design variables, system responds realistically and accurately in real time, allowing the user to explore system behavior freely and to carry out open-ended learning exercises. A host of user-controllable tools are also provided to present a rich learning environment, including: guidance, reference, and exercise materials in hypertext, accessed locally or over the Internet; active links between the guidance materials and the visual representation of the system; tools for modifying system design parameters; a lab notebook for recording design parameter and experimental results; and tools to enable distance collaboration. The software architecture is structured to facilitate separable authoring, in which the domain expert need concentrate only on the physical fidelity of the simulator and the guidance concepts to be taught, while the user interface is built from templates and predefined application objects by someone with modest software skills. Modules covering vacuum and gas flow technology, heat transfer mechanisms, and chemical reaction processes are aimed at novices, while modules in process control and optimization strategies are aimed at more experienced learners. The presentation will feature a live demonstration. Further information is available at the Center for Engineered Learning Systems (CELS) website at /www.isr.umd.edu/CELS/.

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