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CHIP TECHNOLOGY INNOVATIONS AND CHALLENGES FOR PROCESS TOOL SCHEDULING AND CONTROL

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ABSTRACT

The semiconductor manufacturing industry has made extreme technology innovations in circuit width shrinkage, complex 3D chip architecture and high-rise circuit layer stacking, and wafer size increase. These have significantly increased not only process complexity & preciseness and quality & investment risks, but also operational complexity in fabs and process tools. Fab scheduling should cope with more metrology and yield loss, more tool maintenance and tuning, queue time management and complex time constraints between process stages, more restrictions of assigning lots to tools, full automation of wafer lot transfer and direct delivery between process tools, tighter coupling between lot scheduling and material transfer, higher variability and instability in work-in-progress (WIP) and higher WIP imbalance between process stages, etc. We, therefore, need new ideas and approaches for fab scheduling. Process tools also should deal with operational complexities including higher pressure on tool productivity, more frequent chamber cleaning to prevent circuit contamination by residual chemicals, stricter requirements on wafer delays within chambers or on robot arms, separation of processed wafers and unprocessed wafers, more wafer cooling before returning to the loadport, more complicated tool architectures for higher tool throughput and stricter quality requirements, tighter coupling with material transfer systems and complicated interfaces, smaller wafer lot sizes, concurrent processing of multiple wafer types, more frequent exceptional events, etc. There are also issues on interplay between tool scheduling and fab scheduling. We introduce ideas and progress in recent tool scheduling and control, and future directions.

AUTHOR BIOGRAPHIES

TAE-EOG LEE joined Department of Industrial & Systems Engineering, KAIST (Korea Advanced Institute of Science and Technology) in 1991 after his Ph.D. study at The Ohio State University. He has worked on scheduling and control of various robotized process tools, especially cluster tools, for semiconductor manufacturing, and scheduling and control theory for timed discrete event systems, including methods by modeling and simulation, deep learning-based reinforcement learning, real-time tool scheduler SW development, and various industry projects and consulting for tool vendors and fabs. His works appeared mainly in IEEE Transactions on Automation Science and Engineering/Semiconductor Manufacturing, etc. He won the 'Award for The Month's Scientist and Engineer' from Korea Research Foundation and Minister of Science, ICT, and Future Planning in December 2015. He was an associate editor of IEEE Transactions on Automation Science and Engineering (2004~2008) and President of the Korean Institute of Industrial Engineers (KIIE). He is Chairman at Division of Policy Studies in Korean Academy of Science and Technology (KAST). He also has made efforts to transform conventional lecture-based learning & teaching into interactive and student-participative ones and disseminated the strategies and experiences through about 150 keynotes or invited talks. The KAIST cases were reported in Forbes, Nature, Global Engineering Deans Council Conference, etc. For his contribution, he won 'Grand Prize for LINKGENEIS Best Teacher' from KAIST in 2019, and 'Outstanding Contribution Award' from Minister of Science & Technology and ICT in 2021. His email address is telee@kaist.ac.kr. His website is https://koasas.kaist.ac.kr/researcher-profile?perno=6262.