

A steady state analysis of cluster tools: an application of $(\max, +)$ algebra

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Abstract

We consider a cluster tool that consists of a single wafer handling robot and several single-wafer-processing chambers. The cluster tools are used for various semiconductor manufacturing operations since it can have very flexible configurations. We discuss steady state analysis of cluster tools when all wafers have the same processing order as a flow shop. To model timing behavior of a cluster tool, we use an algebraic system, called max-plus algebra. Each chamber processing operation and wafer movement are executed as soon as they are enabled. Given a particular robot movement sequence, we prove the unique existence of the stationary cyclic behavior and identify the schedule. Further, we analyze transient behavior for the periods from the initial empty state to a steady state cycle and from the steady state cycle to the completion of all wafers of a cassette. Finally, we propose a monitoring and control system for cluster tools based on the algebraic timing model.