

Prognostics and Health Management for Semiconductors

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Prognostics and Health Management (PHM) is the discipline that links failure mechanisms to system lifecycle management. Components of PHM have been described at Predictive Maintenance or Condition Based Maintenance (CBM) and their variants (eg CMB+). In the context of the semiconductor factory, PHM includes advanced equipment monitoring and control plus logistical decision-making to jointly schedule work in process (WIP) and maintenance to achieve factory objectives. The system can be designed to maximize factory return on investment (ROI). The PHM system consumes data from the process equipment, off-line metrology, and maintenance records to allow real-time equipment health assessment, early detection of impending or incipient faults, and remaining useful life calculations, and then performs logistical joint WIP and maintenance scheduling based on the equipment assessments, WIP loading, and the operational objectives.

ISMI, the International SEMATECH Manufacturing Initiative, has had a formal PHM project since 2007. The project has defined an industry-specific view of integrated PHM for the semiconductor factory. In recent years the project has performed pilots to demonstrate health assessment and prediction using real data from key process equipment in state of the art high volume factories.

One pilot, performed by a team comprised of Global Foundries, Lam Research, the University of Cincinnati and ISMI, used multivariate projection models to assess equipment component health and predict failure of the electrostatic chuck. The pilot included data from 4 Lam conductor etch platforms of 2 process chambers each over a period of 8 months.

Another pilot, performed by a team comprised of Micron, Novellus Systems, the University of Texas and ISMI, used Hidden Markov modeling to assess process chamber health, and then used match matrix models to predict failure. This pilot also developed a model for joint scheduling of WIP and maintenance in simulation space, using the outputs of the Markov and match matrix models. The pilot included 9

months of production data from one Novellus Systems plasma TEOS oxide deposition tool.

This paper will review ISMI's vision for integrated PHM in the state of the art semiconductor factory. Keys to proper integration will be discussed. Each of the two pilots will be briefly reviewed, including actual results.

