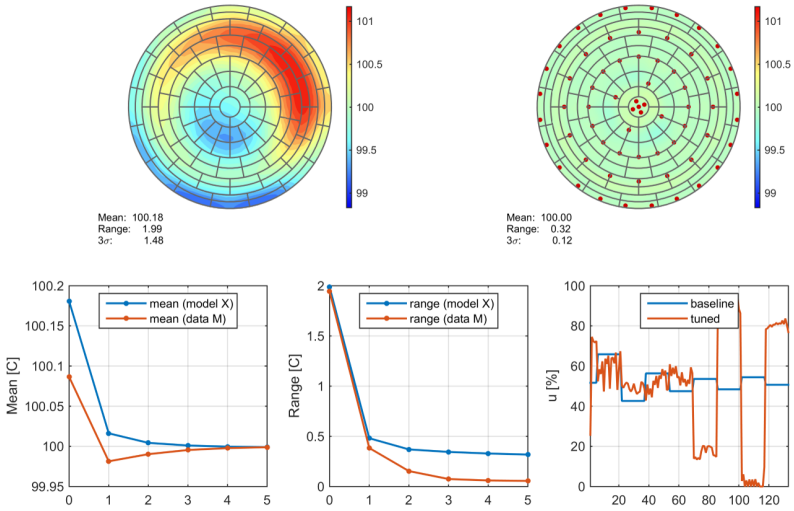
Model-based Tuning of a Multi-zone Heated Plate



Challenge

To achieve optimal wafer temperature uniformity for a wafer heated by a multi-zone heated plate.

BACKGROUND

Driven by ever-increasing requirements on improved wafer temperature uniformity for smaller features on the wafer, equipment manufacturers are developing heated plates (or chucks) with more and more actuator zones to achieve finer resolution of the actuated heat. From a control standpoint, two principally different plate designs can be distinguished: one that has a temperature sensor in each zone in order to tightly control the zone temperature in closed-loop fashion; the other that does not have temperature sensors in each zone, and therefore controls zone temperature by commanding heater power in an open-loop fashion. A third design could be a combination of the above two designs. Each design has its pros and cons, but the goal of both are the same: to achieve better wafer temperature uniformity. Another aspect that is the same in both designs, is that tuning of these multi-zone plates is complex because of the strong heat coupling between the zones.

SOLUTION

MBT-tuner-01That is where SC Solutions' Model-Based Tuner (MBT) comes in to make a

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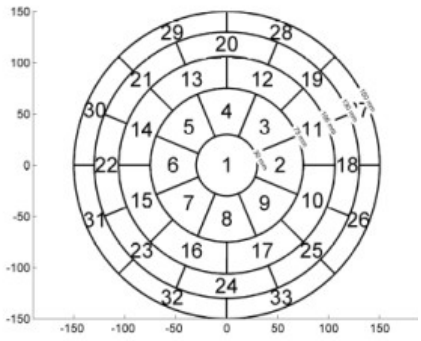
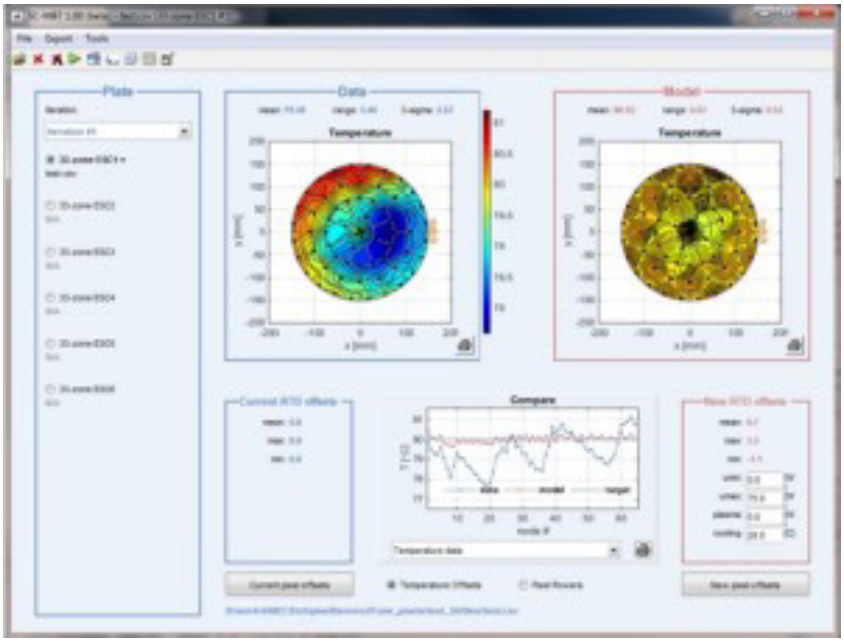
difference. By creating an accurate model of the multi-zone plate heat transfer, and integrating this with SC's proprietary optimization software, a unique tuning software is created that provides optimal wafer temperature uniformity for each plate. The tuning software provides a customized solution that maximizes performance for each customer's unique plate.

As an example, SC built a plate model with 33 zones for a 300 mm wafer process, with a sensor in each zone, allowing for 33 independently controlled and measured zones. The plate itself is a 25 mm thick Al base plate with a 10 mm thick ceramic layer. The gap between wafer and plate is modeled at 100 microns, and the cooling temperature a the bottom of the base plate is held at 20°C. All these and other details are modeled in order to get the most detailed representation of the heat transfer from plate to wafer.



This model is integrated into SC's proprietary tuning software, SC-MBT™, that provide all the inputs and tools for optimizing wafer temperature in a minimal number



of iterations. The tool includes different parsers to read wafer temperature measurements from different measurement wafers such as SensArray wafers. It has the tools to inspect and select the right data slice for optimization, to exclude faulty measurements, or to optimize only over a sub-set of zones. In addition, it has the capability to select or create non-uniform targe profiles, like 'M' (cold-hot-cold) or 'W' (hot-cold-hot) shapes so as to compensate for upstream or downstream wafer non-uniformities. Last but not least, the optimization takes the actuator constraints into account to make sure the best possible wafer temperature uniformity is achieved within the physical constraints of the system.

BENEFITS

SC Solutions' model-based tuning solution provides our customers with a distinct competitive edge. Oftentimes, a model of the heated plate is developed in parallel to the actual manufacturing of the plate, which minimizes time to market. An additional benefit is that for any incoming non-uniform wafer profile, the model predicts the best achievable uniformity with the existing plate hardware. The tuning software automatically calculates the optimal actuation, tremendously facilitating a very complex task for the process engineer. The software is userfriendly and intuitive, and a must-have for any multi-zone heated plate. Lastly, having a unique model-based tuning solution, provides our customers with a continued path for improvement for their next generation plates with increased performance specifications.

If you would like more information regarding model-based tuning, please check our MBT product page or contact us here.

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