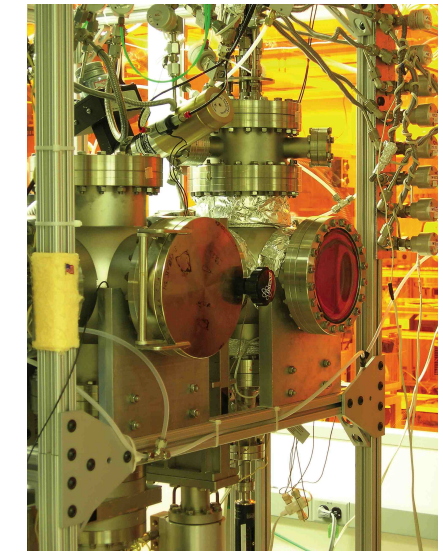




# Full Wafer Map Response Surface Models for Combinatorial Chemical Vapor Deposition Systems

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## Combinatorial CVD

Chemical Vapor Deposition (CVD) is a method for building layers of non-volatile solids in a wafer through the decomposition of relatively high vapor pressure gases. The gaseous compounds of the materials to be deposited are transported to a substrate surface where a thermal deposition occurs.

In some CVD processes, it is necessary to control a film property profile (thickness, microstructure, composition, etc.) to a specific, spatially non-uniform distribution. Through a combinatorial approach it is possible to

- Reproducibly deposit intentionally non-uniform films across the substrate
  - Model the deposition system to correlate processing conditions to desired film qualities
- ⇒ Rapid development of new materials and corresponding process recipes becomes possible

## Response Surface Models

The Response Surface methodology may be divided in three major steps:

- Design of Experiments
- Regression Analysis and Statistical Analysis
- Predictions and Desired Response

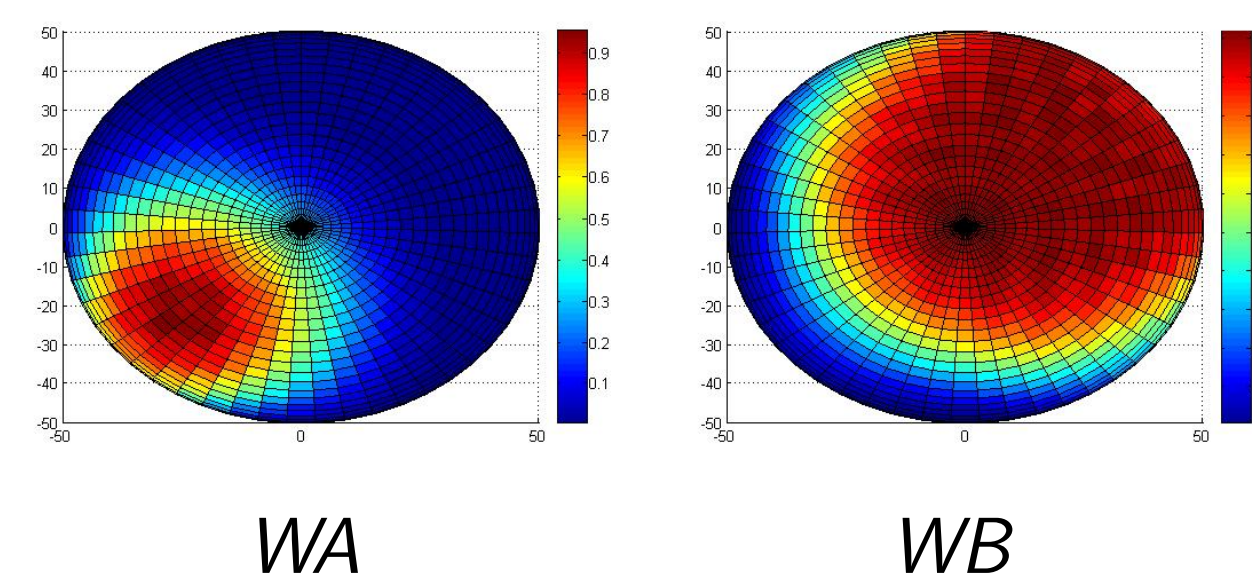
## RSM computational toolbox

- A library of MATLAB object-oriented functions, based on accurate quadrature methods, used for wafer map representation, interpolation and analysis
- Wafer modeling methods that take as input a vector of wafer objects and construct response surface models with output in the form of *full-wafer maps*
- Performs Statistical Analysis on the obtained models

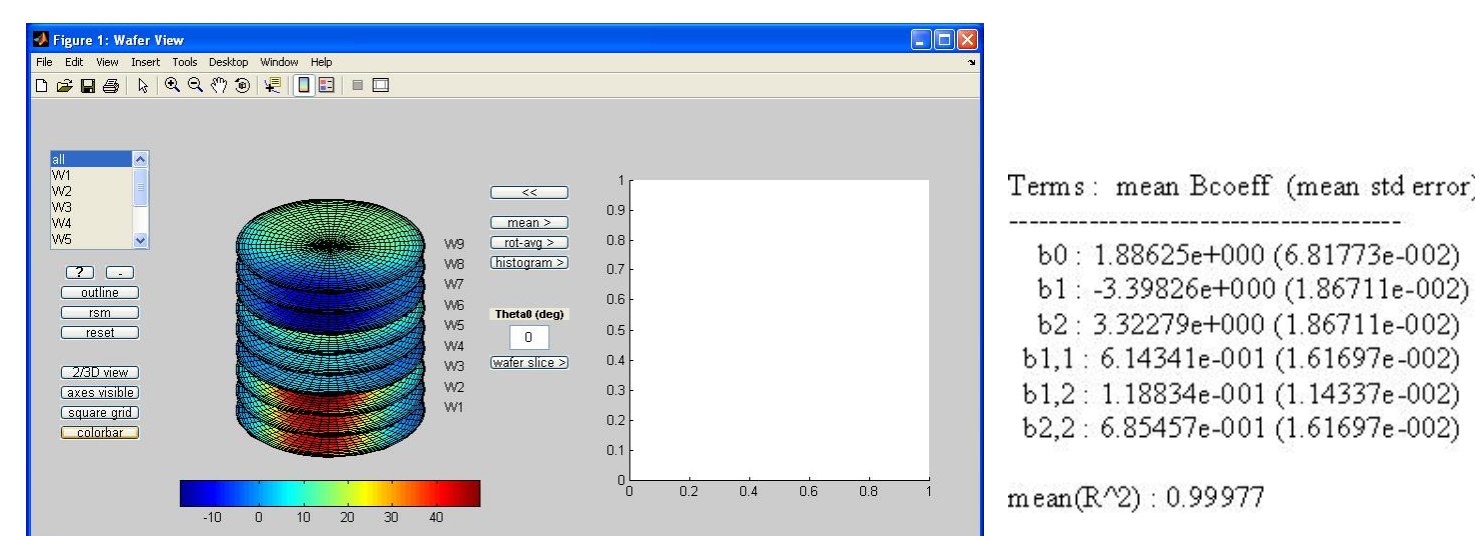
## Artificially Generated Wafers

To test the *RSM computational toolbox* a set of artificial wafers were generated using different values for  $a$  and  $b$  and following the function

$$W = W_0 + WA(a - 3)(a - 0.3)(a + 6) + \dots + WB(b + 5)(b - 0.1) + WA WB(a - 0.3)(b - 0.1)$$

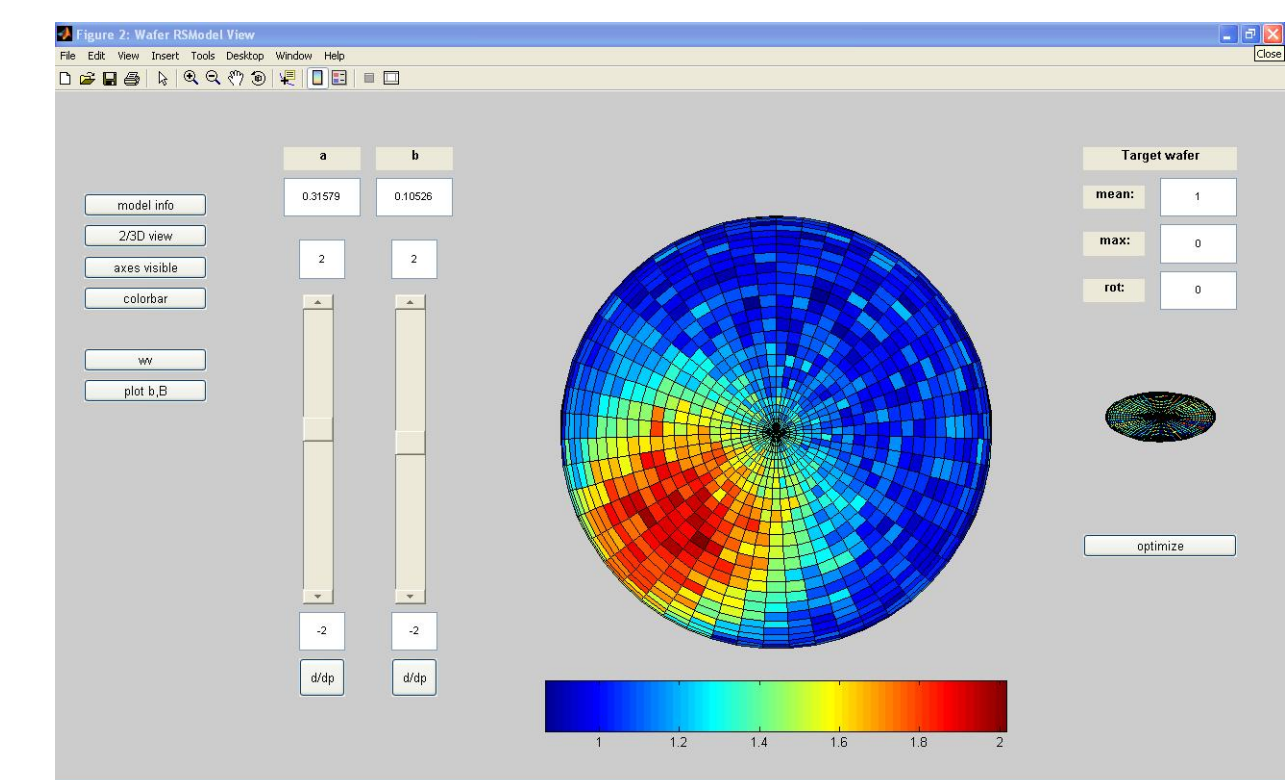


The data generated was given as input to the *waferview* function and a response surface model (2<sup>nd</sup> order) was calculated



## Uniformity as a Desired Response

The “optimal” values for the variables  $a$  and  $b$  that will give a uniform wafer with a mean thickness of 1 are calculated using the *optimize* command on the *Wafer RSMModel View* window



- From the formula used to generate the artificial wafers it is clear that uniformity is achieved when  $a = 0.3$  and  $b = 0.1$
- The calculated “optimal” values using the *waferview* function are  $a = 0.316$  and  $b = 0.105$

## Conclusions

- The usefulness of the *rsmode* toolbox was demonstrated using artificially generated data
- The toolbox is being extensively used for data obtained with a CVD programmable reactor
- Future work includes applying the toolbox on rectangular substrates for CVD of solar energy materials

<sup>†</sup>For more information: <http://www.isr.umd.edu/Labs/CACSE/A-Team>