

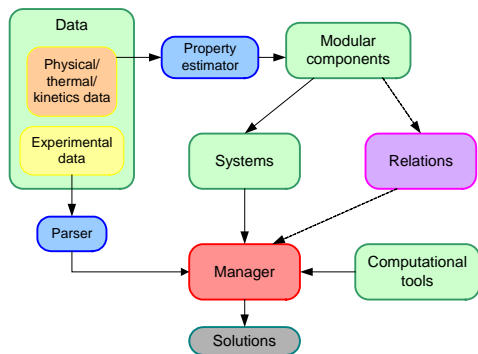
Objectives

- Design a set of computational tools for solving lumped and distributed parameter models generated in process design and simulation
- Develop flexible and reusable modular components for CVD systems
- Apply the technique of object-oriented design to reduce developing cycles of designing new systems and lower costs of CVD process design and simulations
- Facilitate distributed simulation through the application of Java and XML technique to heterogeneous data archiving, analysis and presentation

Why OOP and Modular

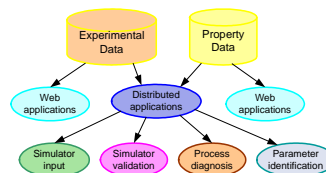
- Features of OOP:
 - Encapsulation
 - Inheritance
 - Polymorphism
- Modular approach:
 - Allow different variable names among modules
 - Allow distributed simulation
 - May solve modules with different algorithms
 - Easy to change model structure

Framework



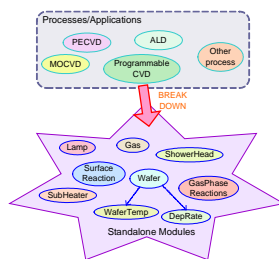
Data

- Archive data in XML format
- Separates data applications and presentation
- Facilitate distributed simulation and information sharing



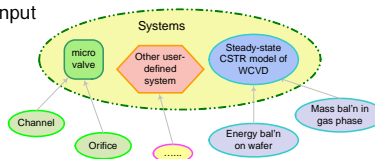
Modular Components

- Standalone modules which could be physical parts or virtual parts describing transport or reaction mechanisms
- Include information on properties of equipment or process and have subsystem equations associated with



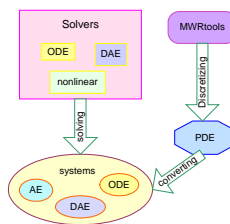
Systems

- Specified by users through input of modularized components
- Acting as a coordinator for information exchanging and distribution among modules in the system

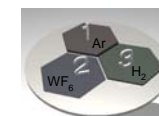
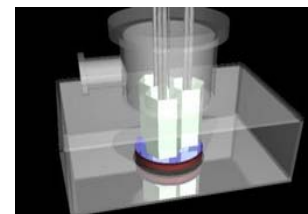


Computational Tools

- Computational tools include two main packages:
 - **Solvers** offer different algorithms for solving AE/ODE/DAE systems
 - **MWRtools** used for discretizing PDE systems and solving the systems by weighted residual methods



Case Study -- Programmable CVD System

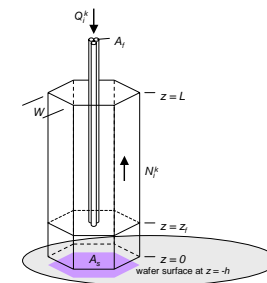
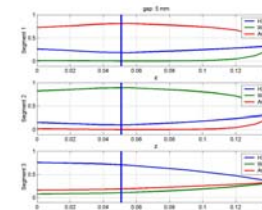


Details on the system and modeling equations can be found in "Spatially Programmable Chemical Vapor Deposition" -- Cho, Adomaitis, et al., 2003

Simulation of gases composition profile along segment

Approach

- **Determine the modules:**
 - one segment class : describe the transportation inside a segment
 - one inter-flux class : describe the diffusion of gases among segment
- **Compose the system:**
 - 3 objects of the segment module
 - 1 object of the inter-segment flux module
- **Solve the system** with non-linear solver



Conclusions

- The application of OOD and modular approach greatly improves current modeling and simulation capability
- The development of the object-oriented simulation library offers a set of flexible and adaptable tools for solving large systems consisting of different application models
- Modularized components can be easily integrated to form a new CVD systems. The system can be solved in the sequential or simultaneous approach depending on the specific applications
- The application of Java and XML technology to wrap and manipulate data facilitates data distribution among dissimilar applications