CFD2000 for Microfluidics

CFD2000 is a powerful engineering tool that is being used by researchers around the world to solve many interesting and complex microfluidic problems. The types of applications being solved include:

- *Bottleneck effect related to compressibility in micro fluidic systems*
- *Hydrodynamic of liquids in micro fluidic systems with slip boundary conditions at walls*
- *Flow in rectangular micro channels*
- *Flow in Hele-Shaw micro cells*
- *Two phase flows, bubbles, drops, wetting phenomena, contact angle*
- *Diffusion process in micro channels*
- *Dispersion effects in micro channels and Taylor-Arris dispersion effects in micro channels*
- *Chaotic mixing*
- *Dispersion effects in the presence of chemical reactions*
- *Electro hydrodynamics in Microsystems (or MEHD – Micro Electro Hydrodynamics)*

CFD2000: Function

With an intuitive user-interface, CFD2000 guides you each step of the way – from grid generation to solution visualization. For micro fluidic applications, CFD2000 can model the key physics:

Particle flows - Chemical reactions - Mixing

Free-surface flows - Electrical Potential

Compressibility – Porous Medium

CFD2000: STORM Flow Solver

CFD2000 uses a fast and efficient 3-D finite-volume Navier-Stokes solver that has been extensively validated against experimental data. By utilizing the integral form of the governing equations, conservation is enforced exactly and the PISO algorithm produces superior steady-state and transient solutions.

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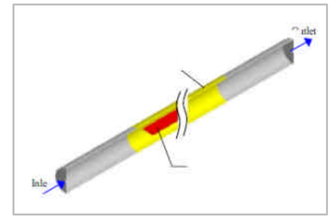
CFD2000 Software – Microfluidic Example Application

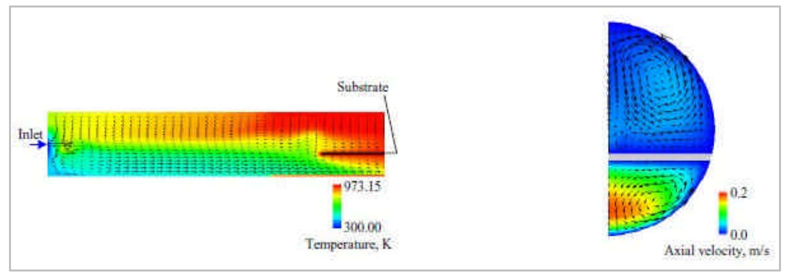
Synthesis of Carbon Nanotubes using CVD Reactor

"Arrays of aligned carbon nanotubes, where nanotubes are oriented in parallel ot each other and perpendicular to growth surface, are of great interest for many potential applications. Because of the excellent electron emission properties of carbon nanotubes, some researchers propose to utilize aligned carbon nanotubes for flat panel displays and highly efficient media for high harmonic generation. Several researchers have developed differing production methods for producing multi-walled nanotubes (MWNTs) using chemical vapor deposition.

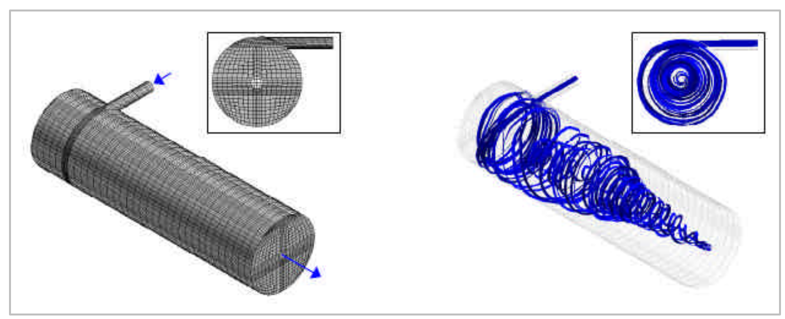
The growth rate of nanotubes depends on temperature, flow rate, and total pressure of feed gas and geometry of reactor. CFD can be used to study the effects of these parameters on the production rate of nanotubes."

Geometrical Configuration of CVD reactor





Temperature and velocity profiles near inlet, and cross-sectional view of velocity field.

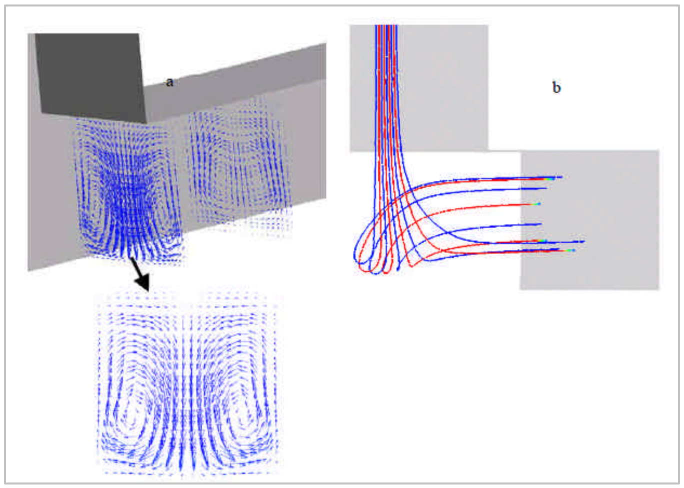


Geometry of side-wall injection, and typical streamlines

CFD2000 Software – Microfluidic Example Application

The Kinematics of Bend-Induced Mixing in Micro-conduits

"The absence of turbulence and the difficulty associated with introducing moving components into microfluidic systems make the mixing problem in micro devices challenging. The feasibility of taking advantage of bend-induced vortices to stir the fluid and enhance the mixing process was evaluated theoretically and experimentally. Since at very low Reynolds numbers the bend-induced vortices decay rapidly, it was necessary to utilize a large number of bends to achieve the desired effects."



Velocity vector fields are depicted at various cross-sections downstream of the bend. Fluid trajectories are also depicted as the flow goes around the bend. Re=80.

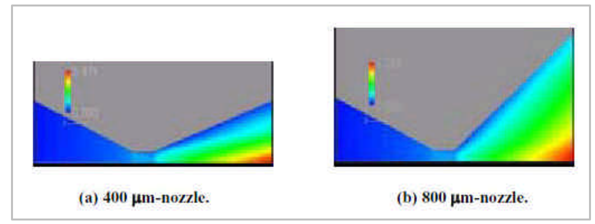
3D Stirrer Configuration

"Secondary flows induced by bends can stir fluids, enhance mixing, and under certain conditions induce chaotic advection. A sufficient length was allowed downstream of each bend to allow the establishment of fully developed flow conditions. Shorter lengths are likely to induce an even more intense stirring process. The stirrer can be easily fabricated using various layered manufacturing techniques such as ceramic tapes.

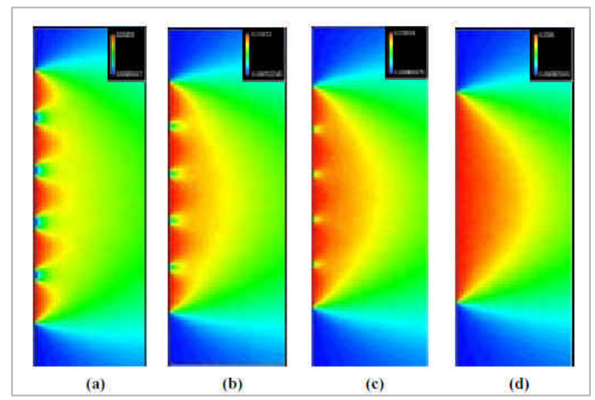
CFD2000 Software – Microfluidic Example Application

Micro-Arcjet: Microfabrication with UV Lasers and Thrust Characteristics

"Preliminary DSMC simulations on internal and exhaust nozzle-flow characteristics of micro-arcjet nozzles including multi-nozzle arrays were conducted. It was shown that the use of multi-nozzle array was effective in suppressing expansion of each under-expanding jet, and in inducing axially confined jets, through the interactions of the jet boundaries, or multi-jet effects. Microfabrication of micro-archet nozzles with firth harmonic Nd:YAG pulses and their operational tests were also conducted. Internal flows of in the micro-arcjet in operation were analyzed using a commercial CFD simulation code: CFD2000."



Mach number contours of internal flows of micro-nozzles with different area ratios, or exit heights of a) 400micrometer, and b) 800 micrometer with same constrictor height of 100 micrometer.



Typical results of pressure distributions for quintuple nozzle cases for different nozzle-separations

a) 100 um
b) 50 um
c) 25 um
d) 0 mu

Contact Adaptive Research

To learn more about the CFD2000 software system please call, e-mail or visit our website.

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