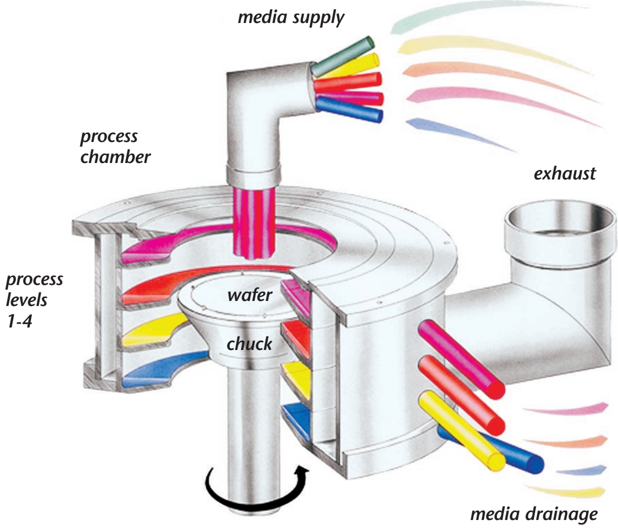


Diagram of the spin process equipment

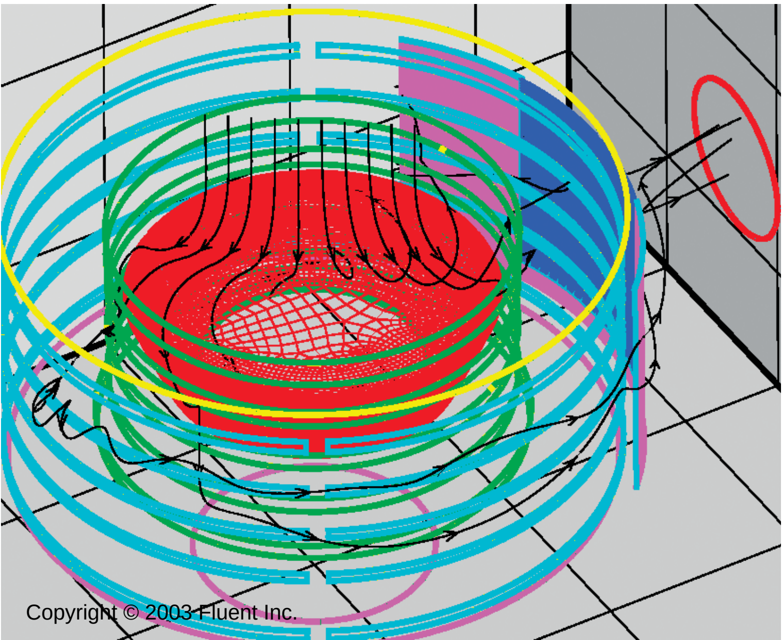
Putting the Spin on Semiconductors

By Bertram Schott and Jarosław Kaczynski, Carinthian Tech Research (CTR) AG, Villach, Austria; and Andreas Baldy, SEZ AG, Villach, Austria

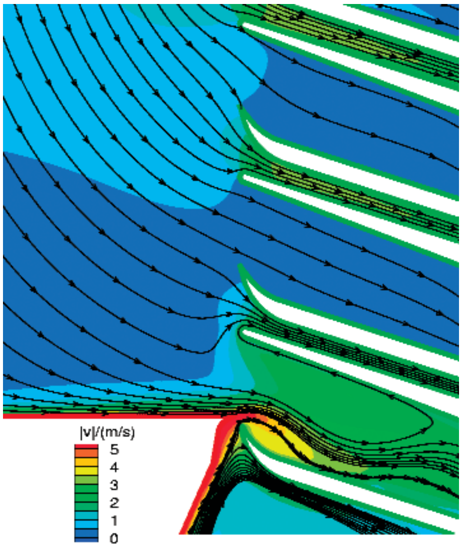
The wet chemical etching of single wafers is one of the most important processes in the semiconductor industry. It is often performed using spin-process technology, developed by companies such as semiconductor equipment manufacturer SEZ AG. Spin-process equipment makes use of a rotating chuck inside a process chamber. The wafer is placed on the chuck with the side to be processed facing upward. Liquid etchant is supplied through a port from above. The jet hits the spinning wafer and the fluid is forced radially outward by the centrifugal force. The process chamber has several vertically aligned annular plates, between which the unused etchant is drained from the processor. By adjusting the wafer height, several consecutive etching processes can be performed during a single process run. Each new wafer position allows the etchant to drain through a separate set of plates, avoiding contamination of one etchant by another. Compared to wet bench processes, in which a stack of wafers is submerged into the etchant, spin processing requires significantly less time to complete. In addition, this particular design from SEZ AG produces high uniformity and unmatched repeatability in the etching process. CFD simulations carried out at CTR AG using FLUENT have provided unprecedented insight into the fluid flow characteristics involved in spin-process technology, and results are being used to optimize the equipment design.

The performance of spin-process equipment can only be improved when the fluid flow inside the equipment is well known. Although the central feature is a fluid jet impinging on a rotating wafer in a gaseous atmosphere, models that focus on the gas flow alone can be very helpful in assessing the performance of the equipment. The gas flow serves the purpose of exhausting toxic gases released by the etching process, and trapping tiny acidic droplets at the walls that result from the spraying of the etchant. To meet these goals, it is important for the gas flow to be homogeneous and have high speeds just above the wafer and plate surfaces. Optimizing the flow inside the spin-process chamber by means of experiments would be much too expensive. In addition, the complex geometry precludes the use of simpler models (such as boundary layer theory) to illustrate the flow with any precision.

Instead of experimental methods or analytical models, CFD has been used to help visualize the gas flow structures in the spin-process equipment. The weak interaction between the liquid and gas justifies the decision to exclude the etchant in the CFD models. The results have allowed the geometry of the device to be optimized to improve the gas flow conditions. The optimized design has alternating narrow and wide exhaust channels. A mixture of gas and etchant passes through the wide channels, where the slower speeds allow the etchant droplets to separate from the gas flow and fall onto the plate surfaces. By contrast, only pure gas passes through the narrow channels at relatively higher speeds. The combination of alternating exhaust channels has a relatively low flow resistance, allowing for increased gas flow rates inside the process chamber, and improved exhaust of toxic gases. Because of successes such as these, CFD simulations are now becoming more and more popular in industrial applications that depend on well controlled fluid flow. ■



Gas flow in a 3D model of the spin process equipment



2D simulation shows the gas flow near the wafer surface and between the drainage plates