FUTRFAB

Two Inch Wafers are the Future

THE FUTRFAB SMALL WAFER NODE

Fred Flitsch, PhD, MBA

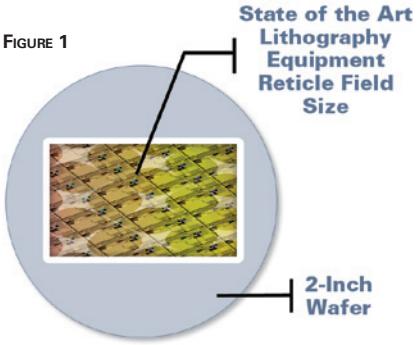
Chief Executive Officer, Futrfab, Inc.

Bucking a fifty year trend toward ever-larger semiconductor substrates, *Futrfab* will greatly improve fabrication efficiency with a wafer of just 2 inches in size. Developed to improve the economics for small volume activity, the Futrfab technology will also make mid- and large-volume fabrication more cost effective.

The *Futrfab Cleanspace fabricator* and *toolPods* make small-wafer fabrication affordable again. That's crucial for inherently small-volume activities like new materials R&D, process and equipment development, and design prototyping. And it's also a cost-effective solution for early-stage manufacturing of products that will eventually be high volume runners.

Futrfab has identified 2 inches as the optimal wafer size for both small- and large-scale fabrication. Today's standard fabrication size is 12 inches (300mm). However, due to the nature of current lithography techniques, that 12-inch substrate is actually processed using multiple repetitions of a single two-inch or smaller reticle field. (See Figure 1). That being the case, the largest die design usable for large-scale manufacturing also works perfectly for small-wafer fabrication.

FIGURE 1



Materials

Two-inch substrate wafers have been in use since the 1970s. Today they're still available and well understood in a variety of materials including esoteric compounds like indium phosphide as well as ground-breaking materials like graphene. In 2010, IBM announced a 100GHz graphene transistor created on a 2-inch wafer.

Small Wafer Economics

For small scale production—a few silicon chips, for example—small wafer production is clearly more efficient than a single large wafer intended for thousands of chips. But what about larger-scale production? How can such a dramatic step backward—from 12 to 2 inches—make economic sense?

> **Advances in automation, coupled with Futrfab innovations, have completely changed the economics of fabrication.**

Based on five decades of industry experience, it's clear that cost-per-unit of silicon tends to go down as wafer size goes up. Also, when considering today's processes, the costs of labor and lithography masks favor ever-larger wafers.

Fortunately, we're no longer talking about today's processes. Advances in automation, coupled with Futrfab innovations, have completely changed the economics of fabrication.

Futrfab's new technology greatly reduces labor costs. Electron beam lithography, a technique unsuited to large-wafer production lines, fits perfectly in a two-inch production environment.

These factors, together with the skyrocketing cost of efficient fabricators, make the *Futrfab* 2-inch standard the fiscally smart choice for small and large-scale production.

An example of the effect of scale: The PC Industry

When standard wafer sizes increase, it's natural to focus on the economies of scale at the end of the production line. A shift from 8- to 12-inch wafers, for example, delivers more than twice the silicon area per wafer produced. 12-inch wafers need less than half as many tools as 8-inch wafers to meet the same demand. As demand increases, the need for tools climbs very slowly. In fact, tooling never achieves any economy of scale. The tools simply become more complex and expensive.

CONTINUED NEXT PAGE >

FIGURE 2

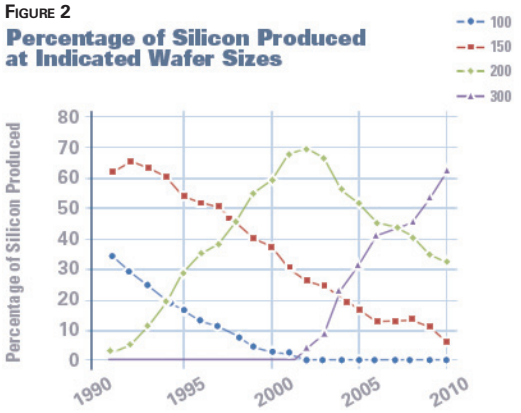
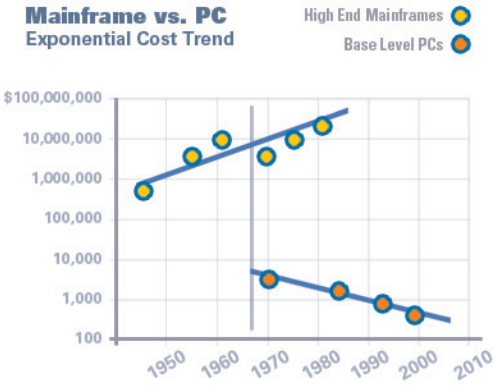


FIGURE 3



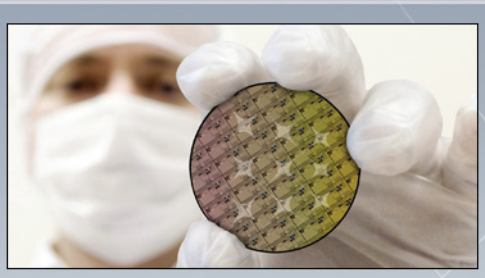
The next-generation 18-inch wafer will offer 81 times the silicon area of a 2-inch wafer. But imagine if, instead of using a single 18-inch tool, the industry utilized a hundred 2-inch tools. Suddenly they would achieve economies of scale. On top of this factor, the *Futrfab toolPod* will include many common components across a wide variety of tool types further increasing the cost-effectiveness of the smaller form factor.

The computer industry itself provides an excellent example of this scaling effect. In the early 1980's the mainframe dominated the industry, demanding an ever increasing infrastructure investment in return for delivering a logarithmically improving cost per unit of calculation.

Then the introduction of a small volume solution changed the industry dramatically. As can be seen in the charts above, the mainframe solution grew more expensive over time while the small-volume PC solution went in the opposite direction. While there's a significant demand for mainframes to this day, the definition of mainframe has changed. Instead of the "big iron" of yesteryear, today a mainframe typically incorporates a parallel implementation of the smaller volume technology.

Just as the economies that accompanied the PC revolution changed the computing industry as a whole, so will the shift "backward" to tomorrow's 2-inch wafer revolutionize the semiconductor industry.

Futrfab, Inc. – Enabling Revolution Through Innovation.



The cost of building a fabrication plant has increased by over 5,000% in the last 30 years. In 1980, a typical state-of-the-art fabrication plant, or 'fab', cost approximately $100 million to build. Today, a truly state of the art fab, costs nearly $10 billion. Given a liberal operating lifetime of 10 years, the fab will need to produce nearly $20 million of gross margin output every week of its life just to cover depreciation costs.

With today's economic pressures, companies face high risks when placing 'novel' designs into large volume production lines. A truly viable small volume manufacturing solution greatly decreases the associated financial risks.

A one-stop resource for R&D, prototyping, production and packaging. Large volume fabrication facilities simply don't support small volume activities well. Research and Development is often done thousands of miles away from the designers. Prototyping is restricted to standardized flows. Packaging is usually performed in far off locations, resulting in weeks of delays due to shipping and customs issues.

A *Futrfab* incorporates every aspect of the manufacturing process into one centralized location for small volume fabrication, and will be the environment of choice for development of new types of components that incorporate or support electronics.

It's the semiconductor fabricator of the future.

Futrfab, Inc.
New York Industrial Plaza
4 Crotty Lane | New Windsor, NY 12553
845.926.4007
www.futrfab.com