The New Space Race: Low-Earth Orbit Manufacturing

The Science:

- Silicon crystals were first grown in 1950. Today, more than 90 percent of semiconductors are fabricated on silicon wafers.
- However, silicon "cannot fundamentally keep up with" the demands of new technologies such as quantum computing, artificial intelligence, and the Internet of Things.
- The future of high-powered semiconductors lies in microgravity manufacturing and in new materials like diamond, gallium nitride, and graphene.
- Gravity is the primary obstacle to more efficient, high-yield semiconductor production.
- Microgravity eliminates convection, sedimentation, and pressure. Combined with a natural vacuum, cleaner facilities, and unlimited solar power, low-Earth orbit (LEO) manufacturing can produce significantly better materials for semiconductors, fiber optics, and many other products.

> "The benefits of semiconductor manufacturing in LEO are clear... Transitioning this industry into space is the only path forward if the United States is to keep pace with the technological arms race unfolding across the globe."
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> *Stanford University Workshop on Semiconductor Manufacturing in the Space Domain*, 2023

The Economics:

- The cost of spaceflight has dropped dramatically. It cost $54,500 to launch one kilogram of materials into space on the Space Shuttle. Commercial vendors can now do it for as low as $951. For context, it costs $200 to ship a kilogram of chocolate from Italy to California.
- A single Taiwan-funded silicon wafer project announced in 2022 was estimated to cost $5 billion. Privately funded space stations have an estimated cost of $3-$10 billion, for platforms that will produce vastly more efficient and powerful semiconductors than the silicon-based technology available today.

The Competition:

- The U.S. first grew semiconductor crystals in LEO on Skylab in 1973. China was the first to make integrated circuits using crystals grown in space. They did it using a recoverable satellite in 1996.
- China is conducting cutting-edge research on its Tiangong Space Station, including the development of new alloys with impressive military applications and conducting large-scale chip testing in orbit.
- The United States shares the International Space Station (ISS) with Russia, the EU, Japan, and Canada. Military research is prohibited on the ISS.
- **The ISS will be decommissioned in 2030. Private companies are investing in successor commercial platforms. If these are not operational soon, China will have the only operational space station capable of using the space environment for development of advanced materials including next-generation semiconductor materials.**

> "This is a gift from heaven," said a materials scientist working in Beijing… "If niobium-silicon alloy can be mass-produced in the future, it will give China a huge advantage in the military and high-end manufacturing sectors. This is proof of how important it is for a country to have its own space station."
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> *South China Morning Post*
> January 7, 2025

Sources: Jessica J. Frick, et al., "Semiconductor Manufacturing in Low-Earth Orbit for Terrestrial Use," Stanford University Workshop on Semiconductor Manufacturing in the Space Domain, 2023; Stephen Chen, "China makes first industrial-grade niobium alloy for hypersonic flight," *South China Morning Post*, January 7, 2025; "China takes its chip war to space as it uses Tiangong space station to test processors and gain a tech edge," *South China Morning Post*, January 24, 2024.