THEWEEK

How Russia-Ukraine war will aggravate semiconductor chip shortage in India

India has brilliant R&D talent in chip design, but manufacturing is the key

Updated: March 14, 2022 17:28 IST

India imports almost all of it semiconductors from countries such as the United States, Japan, and Taiwan. Consumers of semiconductor chips, which are mainly car manufacturers and consumer electronics manufactures, have not been getting enough of this crucial input to continue production, for quite some time now. Raw materials exported from Russia and Ukraine, such as the rare gas neon, chemical C4F6 and metals such as palladium, nickel, platinum, rhodium and titanium, are critical for semiconductor manufacturing. If Russia controls its exports, it can further constrain the supply of semiconductor chips and, in turn, aggravate the situation of chip shortage in India.

“Russia could retaliate against sanctions by cutting off supplies of the neon gas required for the lasers used in lithographic chip-making equipment, notably to Dutch semiconductor company ASML. Ukraine controls about 70 per cent of the global market. Neon gas has been in widespread use for more than 10 years, used in chip plants all over the world. Expanding productivity on high-value resources like this is a long and arduous process. Capacity cannot be added easily or fast in the extraction and refining industries. Because neon must have a purity of 99.99 per cent to be used in semiconductor manufacturing,” said Girish Linganna, MD, ADD Engineering India Limited.

Russia is one of the largest producers of rare-earth metals, especially Palladium, which is an essential metal for semiconductors. Palladium is used in component production. Precious metals such as palladium, platinum and rhodium are also used in the catalytic converters for vehicles. Titanium nitride (TiN) is a widely used material for semiconductor manufacturing, as a diffusion barrier. Interestingly, the world’s second largest exporter of Titanium is Russia (the US being the number one).

“The production of Lithium batteries may also face some turbulence because nickel, of which Russia is a major producer, is an important metal for these batteries. Chip shortage is measured in chip lead time, which is the gap between when a chip is ordered and when it is delivered. Consumers of semiconductor chips, which are mainly car manufacturers and consumer electronics manufactures, have not been receiving enough of this crucial input to continue production. Chip shortage is measured in chip lead time, which is the gap between when a chip is ordered and when it is delivered. In addition to delaying vehicle deliveries, some companies have reportedly started discarding features and high-end electronic capabilities on a temporary basis to deal with the chip shortage,” Linganna said.

As per the latest report from Brickwork Rating, the adverse effect of the Russia-Ukraine war on the manufacturing sector output is likely to be severe as Russia produces 44 per cent of the global supply of Palladium, and Ukraine supplies 70 per cent of the neon output. These are essential inputs for semiconductors. The Brickwork report further pointed out that the supply disruption due to the war will surely cause disruptions in the global supply of chips, and this will adversely impact manufacturing in automobiles, electronic devices and other industries.

Experts pointed out that the automobile industry is already reeling since 2019 under new emission norms, semiconductor shortages and Covid-19’s impact on demand. Whatever the outcome, a tight supply of these raw materials could potentially lead to a rise in semiconductor prices. Semiconductors are essential elements in electronic devices in a number of sectors including healthcare and medical devices, communication, computing, defence, transportation, clean energy, and key emerging technologies like artificial intelligence and quantum computing.

“The semiconductor chip supply is yet to recover from the shock dealt by the Covid-19 pandemic. This, coupled with the war between two states that are contributors to the global supply chain, is detrimental to the industry’s recovery. India's automobile industry is expected to bear the brunt of lower supplies of components triggered by the ongoing Russia-Ukraine war. In technologically advanced automobiles manufactured today, semiconductor devices are used for critical functions, such as sensing, safety features, power management, displays and control of the vehicle,” Linganna said.

Experts pointed out that a long-term road map is essential for India to succeed in the semiconductor sector. While India has brilliant R&D talent in chip design, manufacturing is the key to move up the value chain. Apart from investments, the government also needs to ensure reducing barriers for technology exchange, joint product development, visitation and research participation. This could help India play the long game.

In December 2021, the Union government approved a Rs 76,000-crore production-linked incentive (PLI) scheme to boost semiconductor and display manufacturing - a move that will benefit India strategically, especially at a time when the entire world is facing a shortage of semiconductors. While India has expressed interest in boosting semiconductor production in the country in the past, this is the first time a scheme has been approved to boost manufacturing and reduce import dependency.

Recently, researchers at IISc Bangalore have been collaborating with a semiconductor foundry under the government’s IMPRINT programme, which could provide a solution to address this issue. The IISc team embarked upon developing an indigenous technology platform for manufacturing automotive (analog) chips to be used for commercial and strategic applications. Automotive chips are different from the conventional processor chips used in devices such as smartphones and laptops. An automotive chip (also referred to as a power ASIC) needs to handle various tasks simultaneously, including instrumentation, sensing and control of various electro-mechanical parts.

Experts at IISc said that developing a technology platform that can offer the wide range of capability required by automotive chips has always been a challenge for the industry, and can take five to six years unlike the processor technology platform which typically takes about 1.5-2 years. However, this extra time investment can pay off in terms of a significantly lower obsolescence rate – such chip technologies that can last for 15-20 years without having to be replaced.

Automotive chips require high-voltage switches or transistors built onto the chip. These transistors are called Laterally Diffused MOS (LDMOS). Silicon LDMOS devices are a type of field effect transistors which can operate at much higher voltages than regular transistors. They can also be integrated with billions of other transistors inside a chip. This requirement is also particularly important for space and defence applications.

Keeping these requirements in mind, the IISc team and its foundry partner have been working on developing a range of LDMOS devices (from 10V to 80V) with characteristics matching current industry offerings. The collaborative effort has led to the development of a high voltage automotive technology platform.

“IISc and its partners worked pretty much like an industrial R&D team and handled the fundamental issues differently, which industry usually handles empirically (by trial-and-error). For instance, we could delve deeper into some fundamental issues related to these devices, like Quasi-Saturation behaviour, which hasn’t been completely understood and solved in the past 40 plus years,” said Prof Mayank Shrivastava, associate professor, Department of Electronic Systems Engineering (DESE), IISc Bangalore.

He said that the devices developed have been rigorously tested and found to be robust and the LDMOS devices can now become standard offerings (like any other industry), which will help their foundry partner develop a range of VLSI products in house.