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Semiconductor Policy and "Atmanirbhar" Indian Manufacturing System: Role of Rare Earth Elements

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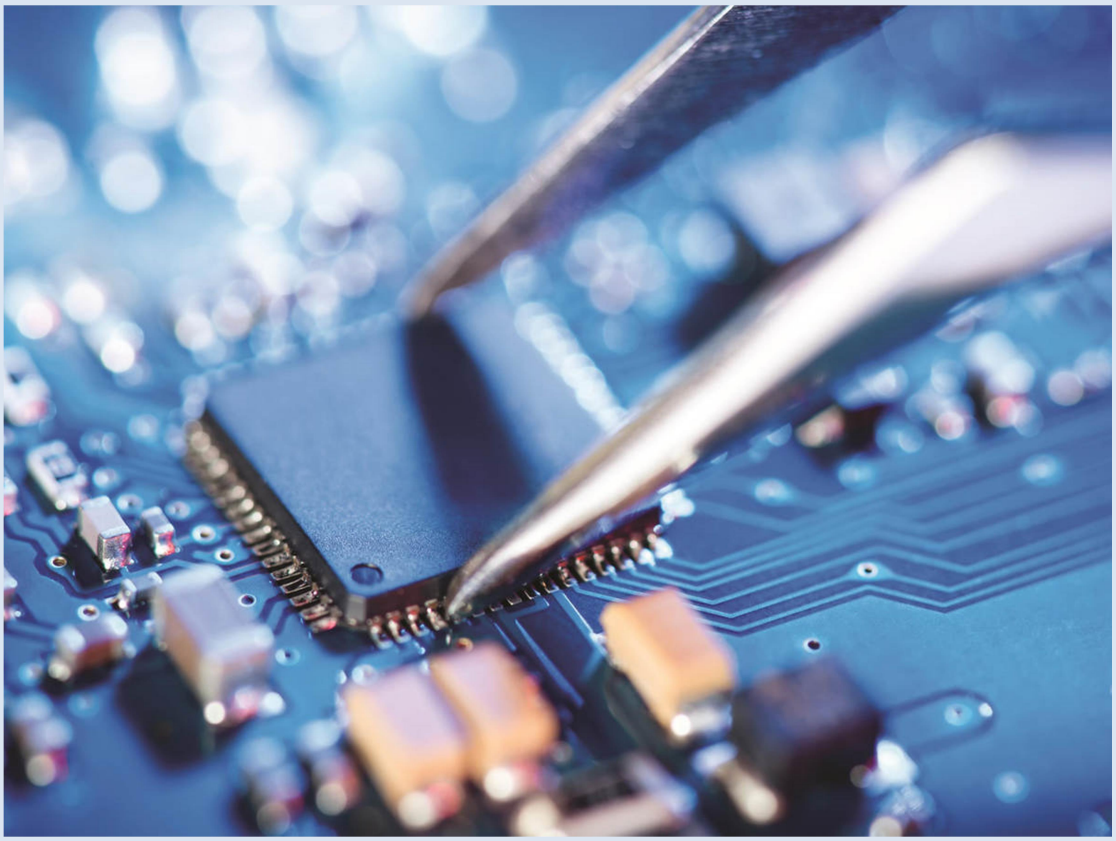

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Since US- China trade war, subsequent Japan-South Korea trade dispute and cyber crisis, the supply chain of semiconductors entered a phase of struggle and got worsened with pandemic. This made countries like the USA, China, Taiwan, Japan, and others enter into the manufacturing of semiconductors.[1] The Union cabinet of India recently approved the 'Comprehensive program for developing a sustainable semiconductor and display ecosystem.'[2], which represents its initiative to move towards its goal of 'Manufacturing Atmanirbharta'.

What are Semiconductors?

According to Cambridge Dictionary, semiconductors are substances with electrical conductivity between a conductor and an insulator. Its conductivity increases with the rise in temperature. A semiconductor consists of elements, aluminium, or a material that allows electricity to move through its body more easily with rise in temperature. Semiconductor constitute elements like germanium and silicon, compounds like aluminium phosphide, and materials such as silicon.[3]

The manufacturing process of semiconductors involves two stages- a) Wafer processing that leads to the formation of Integrated Circuits (IC) involving 400-600 steps in the overall manufacturing process, which are undertaken in one to two months. If any defects occur early on in the process, all the work undertaken in the subsequent time-consuming steps gets wasted and all the processes needs to be repeated; b) Front and Back-end processing that leads to the final semiconductor product, can be used in computers, cars, smartphones, etc.[4]

Use and Significance of Semiconductors

Semiconductors are essential for everyday techno logy needs, from a small bulb to a steering wheel. Some primary usage involves- computers, mobile phones, LED bulbs, refrigerators, internet and communication setup, medical network, clean technologies, and so on. The semiconductors balance the temperature of all the electrical appliances that smoothens the output work.[5]

The use and design of semiconductor chips differ from device to device:

a) Communication- it affects the display, battery, routers, telecommunication.
b) Household Appliances- controls temperature, timers, and automated features of them.
c) Banking- ATMs, security camera, artificial intelligence needs semiconductor chips.
d) Medical Equipment- It directs the temperature, sensor, pressure, calculations, and other functions.
e) Transportation-GPS navigation in cars, buses, trains, and cockpit avionics in aviations.[6]

Impact of Semiconductor Shortage

The shortage caused by Pandemic affected the supply chain of semiconductor chips that impacted the economy of more than 169 countries, as reported by an analysis of Goldman Sachs. The increased use of electronic goods with people working from home led to a significant rise in the demand of semiconductor chips.[7]

The car manufacturers and consumer electronics got most affected by the semiconductor shortages. Patrick Armstrong, CIO of Plurimi Investment, assumed 'the supply shortage will continue for 18 months before the demand-supply equation normalizes.'

However, it is noteworthy that the increase in demand is promising for a better economic system, which implies that if current shortage gets resolved then the future can unfold economic expansion.[8]

Role of Rare Earth Elements in Semiconductor Manufacturing

To control the temperature, Semiconductors require rare-earth elements (REE) that improve silicon solar cells' radiation tolerance and purify GaP crystals. In addition, the use of REE provokes conductivity conversion of semiconductors at low concentrations in the melt.[9]The III-IV compound semiconductors are doped with rare-earth Ytterbium, Erbium, and Thulium, which helps balance the pressure.[10] The abundant reserve of rare earth elements can help the world to overcome the shortage of semiconductors, which requires semiconductor manufacturers and REE reserve countries to collaborate.

India's Semiconductor Policy

The production of semiconductor chips emerges through a global production process. Some companies design them, while some produce them, and some create equipment for their manufacturing, making the process diversified.[11] The present leading countries with semiconductor manufacturing facilities are- United States, South Korea and Taiwan, on which the world, including China, is dependent. Since China launched its 'Made in China 2025' policy, China has achieved prominence in testing, assembly and packaging of semiconductors but lacks efficiency in its design and manufacturing.[12]

As an initiative to join the race to semiconductor self-efficiency, the Union Cabinet of India approved Rs. 76,000 crore outlay for 20 semiconductor design, component manufacturing and display fabrication units (fab) for the next six years. The aim is to develop India into a manufacturing/electronics hub. [13] Following the approval, the Ministry of Electronics and Information Technology (MeitY), Government of India, notified four separate schemes aiming to build a semiconductor ecosystem. These four schemes to set up the following manufacturing plants (Fabs) in India- a) Semiconductor fabs; b) Display fabs; c) Compound/Silicon Photonics/Sensors fab; d) designed-linked Incentive (DLI).[14]

India's Rare Earth Reserves and Capacity

The Department of Atomic Energy (DAE) estimated the total reserves of rare earth in India at 10.21 million tons. The experts of Beach Minerals Producers Association estimated that the Indian rare earth mineral downstream industry could net capital employment of about Rs 121,000 crore, including Rs 50,000 crore worth of foreign exchange. The significant rare earth minerals found in India include- Ilmenite, Sillimanite, Garnet, Zircon, Monazite, Rutile- collectively called Beach Sand Minerals. India has 35% of the world's total beach sand minerals deposits.[15]

The availability of unexploited rare earth reserves and low labour costs can enhance the domestic manufacturing of semiconductors, further enhancing India's global competitive position. Dr Satya Gupta, Chairman of India Electronics and Semiconductor Association (IESA), said that 'Nations must allocate $30 billion over the next 15 years to convert the best chip designers of India into a vibrant fabless ecosystem'. The IESA and Semiconductor Fabless Accelerator Lab (SFAL) are already building a relationship with semiconductor manufacturing companies like Imec (Europe), Samsung (South Korea) and Global Foundries (USA).[16]

The future will unfold if India joins Japan, South Korea, China and Taiwan- the 'Big four Semiconductor Manufacturers'- in Asia. But, if India uses its rare earth reserve potential, the pace can certainly be faster.

Notes:

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