Elements and Technology

G. P. de S. Fernandes

1 INTRODUCTION

Chemical elements play a fundamental role in modern technology: they are the essential building blocks of matter. All the technology ever invented—and that we will invent—depends on understanding and using chemical elements. Every milestone, from putting a human on the Moon to developing nuclear power, was possible because scientists learned how to manipulate these components.

This article investigates chemical elements and their importance for modern technology. The research is subdivided into two main parts—development and conclusion. At the end of this article, it is hoped that the discussion has deepened understanding of the topic and promoted greater scientific knowledge.

2 CHEMICAL ELEMENTS IN TECHNOLOGY

2.1 Chemical elements in modern technology

A chemical element is defined as a set of atoms that share the same number of protons in their nuclei. According to the International Union of Pure and Applied Chemistry (IUPAC), 118 elements are officially recognized; 94 occur naturally, while 24 are synthetic, created in laboratories or nuclear reactors. All elements are arranged by increasing atomic number in the periodic table, which acts as a guide to their properties; each is represented by a standard symbol.

Many of these elements show up in everyday technology:

- **Cobalt (Co)** is relatively rare in nature and is vital for metal alloys used in gas-turbine propellers and for powerful permanent magnets.
- **Polonium (Po)** has been used as a radiation source in early radioisotope thermoelectric generators (RTGs) that powered some experimental satellites.
- **Promethium (Pm)** appears in betavoltaic atomic batteries that once served in missile guidance systems and a few highly specialized electronic devices.
- **Iron (Fe)** accounts for around 95 % of global metal production, underpinning ships, automobiles, building frameworks, and countless tools.
- **Krypton (Kr)** is found in certain high-intensity discharge and fluorescent lamps, including some airport approach-lighting systems, because its bright emission lines enhance visibility.

2.2 Technological Applications: Properties and Characteristics

Physicochemical properties—such as atomic radius, density, and melting point—explain why particular elements suit specific technologies. When the periodic table is arranged by atomic number, many properties vary in a repeating pattern (Moseley's law). Key properties include:

- **Atomic radius:** the distance from an atom's nucleus to its outermost electron shell.
- **Atomic volume:** the space occupied by one mole of an element in the solid state.
- **Absolute density:** the mass-to-volume ratio of a substance.
- **Melting point and boiling point:** the temperatures at which a substance changes state.
- **Electron affinity:** the energy released when a neutral atom gains an electron to form an anion.

Because of these properties, cesium (Cs) and francium (Fr)—with large atomic radii—are useful in ultra-precise atomic clocks and certain electronic devices. Very dense elements such as osmium (Os) and iridium (Ir) excel in jewelry, precision weights, and catalytic converters. Tungsten (W), with its exceptionally high melting point, remains the metal of choice for incandescent-lamp and specialty filaments.

2.3 Application Areas

In the area of medicine, krypton (Kr) is used in the production of krypton lasers for eye retina surgery, and Holmium (Ho) is used in the manufacture of lasers applied in medicine and dentistry. Additionally, gadolinium (Gd) is frequently used in MRI scans to diagnose tumors. In the area of agriculture, we can mention the element phosphorus (P), which produces phosphoric acid, which is important for agriculture, used as fertilizer.

An example that we can cite of an important chemical element for the electronics area is palladium (Pd), being used in the electrical industry, in electromechanical systems, and tantalum (Ta) is also widely used in the electronics industry, taking as an example the manufacture of resistors and capacitors. Another use would be in the production of medical implants. Copper (Cu) is a fundamental pillar for electrical installations and can be used as an electrical conductor.

3 THE CHEMICAL ELEMENTS PRESENT IN THE SMARTPHONE

Constructing a modern smartphone requires a surprising variety of elements. The lithium-ion battery relies on lithium ions moving between electrodes: the cathode is typically lithium cobalt oxide ($LiCoO_2$) laminated to aluminum foil, while the anode is graphite (carbon) coated on copper foil.

Within the phone's circuitry, copper (Cu), gold (Au), and silver (Ag) form crucial conductive pathways. Silicon (Si) dominates semiconductor chips, serving as the foundation of processors and memory. Lead (Pb) and tin (Sn) appear in the solder that bonds components to printed circuit boards. The touchscreen depends on a transparent layer of indium tin oxide (ITO), a compound of indium (In) and tin (Sn) that conducts electricity while remaining clear. Combining gallium (Ga) and arsenic (As) yields gallium arsenide (GaAs), enabling high-frequency semiconductor devices and many infrared laser diodes used in optical media readers.

4 CONCLUSION

The facts discussed above underscore the importance of chemical elements in modern technology—their properties dictate their applications, and their strategic use spans fields as diverse as medicine, agriculture, and consumer electronics. A society ignorant of chemical elements would lack true technological awareness, because these elements underpin everything from the machines that manufacture drugs to the surgical instruments that save lives. In short, chemical elements form technology.

Works Cited

Castillo, Rubens. “Periodic Properties of the Elements: Understand What They Are.” *Regional Chemistry Council*, n.d. Web. Accessed 24 February 2025.

Regional Chemistry Council. “Chemical Composition of Cellular Devices.” *Regional Chemistry Council*, n.d. Web. Accessed 24 February 2025.

Torres, Wyllian. “Discover These 30 Chemical Elements and Their Uses in Everyday Life.” *Canaltech*, 5 June 2021, www.canaltech.com.br/ciencia/30-elementos-quimicos-e-suas-utilidades-no-cotidiano-185024/. Accessed 24 February 2025.

Hamann, Renan. “What Are the Major Applications of the Chemical Element Gallium in Current Technology?” *Tecmundo*, 28 Sept. 2016, www.tecmundo.com.br/quimica/109980-grandes-aplicacoes-elemento-quimico-galio-tecnologia-atual.htm. Accessed 24 February 2025.