

## Replacing Minor Metals with Abundant Materials for a Greener Future

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Today, we use many minor metals in our daily lives. They work like seasonings in cooking. Some of them add strength when mixed with other metals. Some metals affect how well electricity flows. These metals are found in electronic devices like smartphones. A smartphone has nickel, lithium, palladium, platinum, gallium, and some other minor metals. Minor metals also play important roles in factories. Some promote reactions and help make clothes, food, and medicine. They are also used to clean polluted air from cars and factories. We might not notice them, but minor metals are very important in our lives.

But minor metals are called “minor” because we don’t have a large amount of them on Earth, or it is difficult to separate the metals from the rocks containing them. The amount of minor metals is small, but many people need them, especially for technology. The IT industry is growing so rapidly, and it needs a huge amount of minor metals, so the prices are increasing. Also, minor metals are found only in a few countries. If those countries have economic and political problems with others, they might stop sending the metals to their opponents. This makes it difficult for many people to keep getting these metals at a low price.

So, what can we do to fix this problem while maintaining the quality of our lives? One solution is to recycle minor metals. They can be separated from old smartphones and other used electronic devices. The idea is called an “urban mine”. There are still some problems with the cost, but the idea has been realized. In the Tokyo Olympic Games, the medals given to the athletes were made from recycled metals from used

smartphones. Another solution is that we might be able to find something else to use instead of the metals.

Of course, it is easy to find nitrogen, carbon, oxygen, and hydrogen. They are found in the air, water, and living things. They are also cheap. But they don't act like minor metals in chemical reactions because their structures are different from those of minor metals. Still, they can be used as basic materials to build things that can work like minor metals as materials.

Some minor metals, such as gallium, are used in switching, detecting, producing sound and light, memory devices, and operating electric equipment. Recently, materials made of carbon, nitrogen, oxygen, and hydrogen have been produced to replace those minor metals. For example, LEDs are used as an economical and environmentally friendly lighting option at home or in workplaces. They contain gallium and iridium. They are both minor metals. Some companies sell LED lighting using carbon, nitrogen, oxygen, and hydrogen, and other, cheaper elements as a light source.<sup>1</sup>

Now, let's think about how to replace minor metals used to promote reactions. Most metals come from rocks. Silicon, aluminum, and iron are the most abundant metals in the rocks on the surface of Earth. Silicon is used to make glass, so it becomes strong and stable with oxygen. It might be too stable when combined with oxygen to promote reactions. Aluminum is light and useful, but it doesn't work like minor metals. Also, it needs a lot of energy to separate it from the rocks. Iron is found in many places, and it is cheap. Its structure is more like that of some minor metals that promote reactions, so it might work similarly. That's why iron could be a good choice to replace minor metals in some reactions.

While iron can be a good choice as a replacement for some rare metals, there is a reason why iron has not been much used in reactions. The structure of iron is too complicated, and it is difficult to control how iron works in reactions. In that case, we usually try to control the reaction using something called ligands. They are attached to metals, and they can control the direction in which other chemicals approach the metals and protect the metal from substances that can stop the reaction by covering the metal. Also, they control the reactivity of the metal itself and select the reaction to take place. In other cases, other chemicals are added to help reactions take place. <sup>2</sup>

While it is currently not possible to replace minor metals completely as materials and in reactions, since they are too useful, there are some problems with the alternatives. They are still in the developing stage. However, just by replacing some of the minor metals with other easy-to-find materials, the price will be lower, and our lives will be more environmentally friendly.

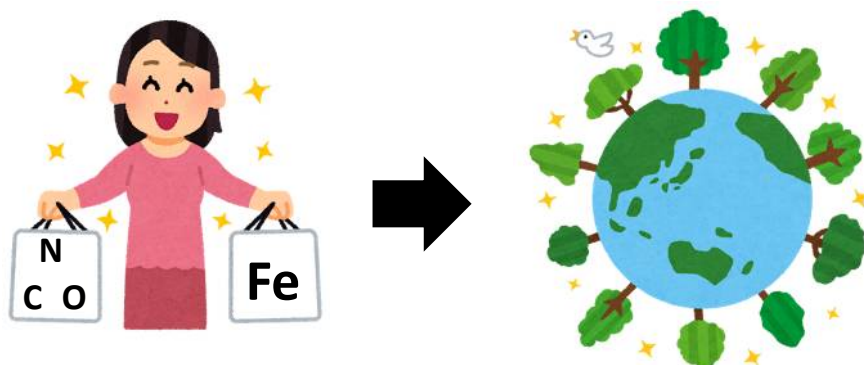
As we look for ways to reduce our dependence on rare resources like minor metals, we also need to consider the bigger picture—how our lifestyle affects the planet. There is no doubt that human life affects the Earth's climate. We all feel that summers are getting hotter and hotter. The Internet and smartphones are too convenient to abandon. We rely on air conditioners during what is often called “the hottest summer ever recorded.” These conveniences and inconveniences are both the results of science and technology.

We all know that our lifestyle puts pressure on the environment. But it's important to remember this: science and engineering have also provided us with solutions. In the 1950s and 60s, Japan suffered from severe pollution, both in the air

and in the water, but science and engineering helped us find ways to reduce further damage.

Today, even in a big city like Tokyo, the air is acceptably clean. That is thanks to the efforts of people who used knowledge, creativity, and courage to find solutions. The future will also be shaped by science and engineering.

Science is not only for geniuses. It is for anyone who is curious, who asks questions, who is brave enough to face problems and search for answers. You have the power to think, to ask, and to act. Stay curious, stay aware, and remember: our future depends on the choices you make today.



#### Acknowledgments

I used Grammarly for spell check and ChatGPT to assist with grammar checking and improving expressions.

Free images were used (<https://www.irasutoya.com>).

#### Reference

- 1) Zou, S.-J. et al. *Mater. Chem. Front.* **2020**, 4 (3), 788–820.
- 2) Rana, S. et al. *Chem. Soc. Rev.* **2021**, 50 (1), 243–472.