

Is Your Phone Sustainable?

By Michael Tinneland

You might have heard that the world is on the verge of running out of certain elements and compounds, and that our use of such materials is not sustainable. That is, we can't meet "the needs of the present without compromising the ability of future generations to meet their own needs," according to the United Nations' definition of sustainable development.

For example, experts say that we're on the road to depleting global supplies of indium within the next 100 years. The metal comes from zinc mines around the world and is often combined with tin and oxygen to form thin films of indium tin oxide ($\text{In}_2\text{O}_3\text{Sn}$). These films are the conductive, transparent coatings that enable touchscreen technology.

But you've learned that matter can't be created or destroyed. So, if atoms are forever, what does it mean to run out of certain elements? Do they age and wear out? If the supply of indium runs dry, would this mean the end of touchscreens?

The age of atoms

To address these questions, it helps to know how old atoms are. The vast majority of atoms in the world are extremely old. There are exceptions—for example, when atoms undergo nuclear reactions such as induced fusion reactions or natural radioactive decay. These reactions can lead to atoms having extremely short lives. But most hydrogen atoms, which formed soon after the Big Bang, are more than 13 billion years old. Atoms of other elements formed in various stars, and their ages differ. Most atoms on Earth, including the ones that make you who you are, are billions of years old, too.

In other words, the idea of an atom's "age" is very different from the age of a person, place, or thing. Atoms can constantly be recycled and take part in chains of chemical reactions without wearing out. This is consistent with the concept that matter can't be created or destroyed. You might have studied common examples of how this works, such as the carbon cycle. A carbon atom that is part of your skin right now might once have been part of a plant and might later become part of a gas in the atmosphere.

Changing the cycle

If recycling occurs constantly with most atoms existing for eons, how do we run out of an element?

Problems arise when natural cycles become



What is indium?

■ Indium is a soft, silvery metal. It was discovered in 1863 in Germany.

Where is it found?

- It is mainly found in zinc ores.
- China produces about half of the world's refined indium.

How is it used?

- Indium tin oxide and, to a lesser degree, indium zinc oxide make up the conducting, transparent coatings in solar panels and touchscreens.
- Other uses include batteries and bearings.

Weird fact

- Indium makes a crackling sound when bent.

unbalanced, which often happens with the large-scale production of stuff. So, while atoms and molecules don't get too old, they might get stuck in consumer goods that do wear out and

can no longer be recovered in a cost-effective way. We often stash indium-containing phones in desk drawers or send them to landfills when we buy a new one. In doing so, we make those atoms inaccessible for re-use. Meanwhile, the number of products that contain indium keeps going up.

In 2015, a U.S. Department of Energy report noted that indium production from zinc mines was easily meeting demand. But it also predicted that the price of indium would likely go up considerably over the coming decades as the supply dwindles.

Would touchscreens then become unaffordable? Some experts doubt that this will happen. Scientists have been studying replacements for indium tin oxide, with graphene being one possible substitute. Graphene is a material made of a single layer of carbon atoms arranged in a honeycomb-like lattice. Experts have called it a wonder material because it's stronger than steel, more elastic than rubber, and more electrically conductive than copper.

Still, indium isn't the only element that's expected to become increasingly difficult to source. There are many examples of endangered elements, including neodymium, which is used for motors in hybrid and electric cars. So, while adapting new technologies can help improve certain aspects of our lives and the environment, they often require the use of limited raw materials that could require replacing in the future. Whether these cycles of shifting resources meet the definition of sustainability is open for discussion.



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