## Adopt Me. And change my world.



#### MATERIALS SCIENCE

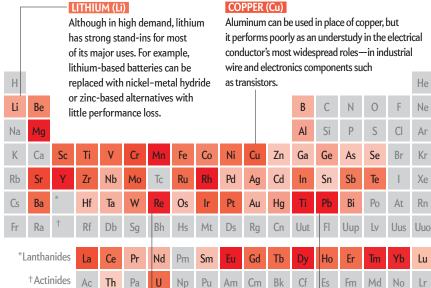
### Elemental Urgency

Most metals currently lack substitutes

Half a century ago only a handful of materials were in widespread use for consumer and industrial products-wood, iron and brick, to name a few of the most prominent ones. Today a single computer chip contains more than 60 elements, ranging from tungsten to ytterbium. Contemporary technology's reliance on such diverse resources, particularly metals, piqued the interest of Thomas Graedel, an environmental scien-

#### The Periodic Table of Substitute Availability

#### LITHIUM (Li)



#### RHENIUM (Re)

A by-product of copper and molybdenum production, rhenium is one of the rarest and most expensive metals. A shortage roughly a decade ago forced engineers at General Electric to develop new alloys that could replace rhenium in jet-engine turbine blades.

Substitute Performance

#### LEAD (Pb)

Lead consumption is on the rise, chiefly in response to demand for backup batteries and protective sheathing for underground wires. No alternative materials exist for such uses, but new technologies such as long-sought fuel cells could replace lead-based batteries.

tist at Yale University. With increasing

table in all their uses. Graedel and his

colleagues found after a comprehensive analysis of the elements' properties, life

cycles and applications. And inadequate or

nonexistent alternatives plagued a dozen

metals when it came to their major uses.

There may be a silver lining to situation-

-Jennifer Hackett

Replacements in these cases invariably

al scarcities, however, Graedel says. They

should inspire engineers to design com-

pletely novel, transformative materials.

would lead to degraded performance.

demand for these elements, are replacements available if a shortage occurs?

In most cases, no. In fact, strong substitutes exist for none of the examined 62 metals or metalloids on the periodic

Element not evaluated

# ATERIALS BASIS OF MODERN SOCIETY, "BY T. E. GRAEDEL ET AL., THE NATIONAL ACADEMY OF SCIENCES USA, VOL. 112, NO. 20; MAY 19, 2015 SOURCE: "ON

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