

Imaginary futures

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Silicon is not an ideal material for photovoltaic solar cells. Its optical absorption peaks in the deep violet, not sunny yellow. And its bandgap is indirect—that is, additional energy from lattice vibrations is needed for photons to excite electrons into the conduction band. Indirect bandgaps make for inefficient current generators.

Despite those disadvantages, silicon remains the most widely used material in solar cells. First-generation cells used crystalline silicon; their successors use polycrystalline silicon or amorphous thin-film silicon. The element owes its predominance largely to industry's familiarity with making devices from it. What's more, its closest current rival, thin-film cadmium telluride, combines a toxic element with a rare one.

Chemists, materials scientists, and physicists are searching for alternatives to silicon and cadmium telluride. Perovskites and organics show promise. But as you'll discover on page 34, silicon itself is a potential contender. In his feature article, Craig Taylor notes that silicon has 14 different structural forms or allotropes. Most are produced at high pressure and in tiny quantities. Still, according to calculations performed by José Flores-Livas of the University of Lyon and his collaborators, some of the allotropes could be efficient photovoltaics.¹

But there's little scientific basis to believe that silicon could serve in another important position: that of life's principal atomic building block. Although silicon lies beneath carbon in the periodic table and has similar chemistry, it's chemically less versatile and available. Crucially, silicon atoms are too big to form double bonds, which feature prominently in carbon biochemistry.

Despite its implausibility, silicon-based life remains a science-fiction staple. In his 1955 short story "The Talking Stone," Isaac Asimov described shrew-sized telepathic "siliconies," which live off the gamma rays emitted by radioactive

ores. Perhaps the most famous silicon-based life forms are the Horta, which starred in "The Devil in the Dark," a 1967 episode of the original *Star Trek* series. After several misunderstandings, Captain Kirk and Mr Spock helped the members of a mining colony recognize that the boulder-like Horta were

benign. Of more recent vintage are the Sekkari, an extinct civilization of silicon-based life that populated the Pegasus and Milky Way galaxies in *Stargate Atlantis* (2004–9).

The four news stories that appear after page 40 are neither as factual as Taylor's review of silicon allotropes nor as fanciful as siliconies, Horta, and Sekkari. Back in April, PHYSICS TODAY announced a competition that challenged readers to write a news story about physics in 2116. Robert Austin's account of the construction of a huge space telescope out of laser-machined asteroids was the winner. The three that follow it were the runners-up.

If a precursor of PHYSICS TODAY had held a competition in 1916 to imagine physics a century hence, I wonder if any of the entries would have described a device that can image individual atoms, the slowing of light to a dead stop, or the delivery of a mobile laboratory to the surface of Mars—to mention just three modern achievements. Speculating on future physics is hard. I thank and admire everyone who entered the competition.

In my research for this column, I looked for scientific papers that included the phrase "silicon-based life." In one that I found from 1975, environmentalist James Lovelock noted that, based on our knowledge of the properties of the elements, it was unlikely that silicon-based life had evolved.² But he went on:

On the other hand we have ample experience of the possibility of life based on electronic and mechanical contrivances; a biosphere of this form would evolve presumably from a chemical one perhaps starting in symbiosis with it.

Here is the germ of what might have made for a foreboding entry in PHYSICS TODAY's essay contest: Artificial life evolves and coexists alongside natural, carbon-based life—until it takes over.

References

1. S. Botti et al., *Phys. Rev. B* **86**, 121204 (2012).
2. J. E. Lovelock, *Proc. R. Soc. B* **189**, 167 (1975).



**MARS IN
SCIENCE FICTION**
is the subject of an essay by
**BOOKS EDITOR
MELINDA BALDWIN**
on PHYSICS TODAY's
website.