

Here's Another Use for Ice: Creating Secret Codes

Scientists have devised a way of writing and storing messages by creating patterns of air bubbles in sheets of ice.



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A new study by Chinese, Korean and Czech scientists points to a novel way of writing and storing messages: creating patterns of air bubbles in sheets of ice. While the researchers aren't expecting you to ditch your smartphone, their study speaks to the remarkable properties of frozen water.

"I could see it showing up in a James Bond movie," said Robin E. Bell, an expert in ice sheet dynamics at Columbia and a former president of the American Geophysical Union. Dr. Bell, who was not involved in the new study, pictured a scene in which secret plans involving a submarine are encoded in an ice cube and are in danger of being discovered. "So you turn it into a smoothie or something," she said.

But the idea is more than an exercise in frivolity, said Mengjie Song, an expert in thermodynamics at the Beijing Institute of Technology and one of the lead authors of the new study, published on June 18 in the scientific journal *Cell Reports Physical Science*.

“It is a totally new method for humans to record information,” Dr. Song said. In his view, there could be “many, many applications around this work.” For instance, it could be used to help devise more accurate models for de-icing power lines, airplanes and high-speed trains. A clearer grasp of how ice bubbles form could also help scientists better understand the thermal and mechanical properties of bricks made from lunar soil, which could be used to build moon bases. (Scientists have been researching the possibility of fashioning bricks from Martian soil for almost a decade.) Trained to recognize patterns in ice bubbles, artificial intelligence could help study glaciers for clues about past climate patterns, or to identify potential deposits of natural gas.

Researchers acknowledged, however, that much more work would have to be done to make such applications feasible. “Ice is an ancient substance that permeates every aspect of our lives,” Dr. Song said. “There are many unsolved mysteries waiting for us to explore.”

Indeed, ice itself is something of a mystery. Covering about one-tenth of Earth’s surface, ice continues to yield clues about the planet’s distant past while pointing to a much warmer future. Ice can preserve ancient viruses. Ice can also sing.

Bubbles form in ice when air becomes trapped during the freezing process. As water turns from a liquid into a solid, its molecules arrange into hexagons. Most of the gases are expelled during that phase transition, but some get stuck.

“Every time you take an ice cube out of your freezer at home, you will see that the outside might be clear but the inside of the ice cube is very opaque,” said Jochem G. Meijer, a postdoctoral scholar in fluid physics at the University of Chicago. “This opaqueness is because a lot of tiny bubbles have been frozen in the ice.” Conversely, Dr. Meijer noted, a cocktail at a “fancy bar” might be accompanied by bespoke ice cubes that are clear and bubble-free. “Then you can be sure that they spent quite some money on it,” he said.

Dr. Song and his colleagues carried out their experiment by freezing a sheet of water between two acrylic plates. They found that by changing the speed of freezing and the tilt of the plates, they could alternatively produce egg- or needle-

shaped air pockets in the ice sheet. Those shapes could be rendered into Morse code, which relies on dashes and dots, or a computerlike code that uses either two or three different symbols. A camera captured the sequence of shapes, which were subsequently processed by a computer and translated into English letters and Arabic numerals.

“The work is impactful overall,” said Jonathan B. Boreyko, a fluid mechanics expert at Virginia Tech. “The level of control obtained for the ice bubble shapes and distributions is impressive.” Dr. Boreyko added that the experiment was a “superb” means of directing public attention toward something many take for granted.

Ice bubbles are already known to hold clues about the atmospheric conditions that prevailed when they were formed. “We can not only make a message, but we can know the message inside it,” Dr. Song said.

For his part, Dr. Boreyko said that although ice bubbles would probably not replace text messages and tweets, the new findings were important. “Science often works this way,” he said. “We get surprised and captivated by a particular phenomenon, try to understand it out of pure curiosity, and then unexpected applications emerge downstream,” he said. Not all bubbles, maybe, are fated to burst.

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