SEMICONDUCTOR ENGINEERING

SYSTEM-LEVEL DESIGN

System Bits: Oct. 18

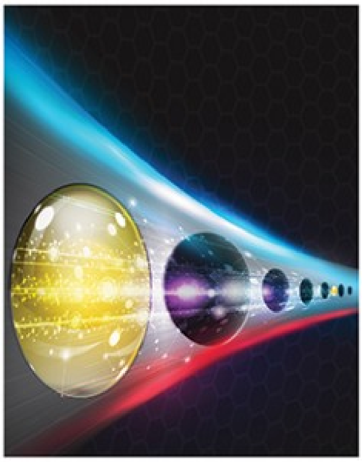
Diamonds aren't forever; Marconi-inspired chip design; controlling nanomaterials.

OCTOBER 18TH, 2016 - BY: **ANN STEFFORA MUTSCHLER**

First quantum computer bridge

Quantum computing is closer than we think. For the first time on a single chip, **Sandia National Laboratories** and **Harvard University** researchers have shown all the components needed to create a quantum bridge to link quantum computers together by forcefully embedding two silicon atoms in a diamond matrix.

Sandia researcher Ryan Camacho pointed out that small quantum computers have already been built, and possibly the first useful one won't be a single giant quantum computer but a connected cluster of small ones.



This stylized illustration of a quantum bridge shows an array of holes etched in diamond with two silicon atoms placed between the holes. (Source: Sandia National Laboratories)

By distributing quantum information on a bridge, or network, novel forms of quantum sensing maybe be enabled, since quantum correlations allow all the atoms in the network to behave as though they were one single atom.

The team used a focused ion beam implanter at Sandia's Ion Beam Laboratory designed for blasting single ions into precise locations on a diamond substrate. The Sandia researchers used implantation to replace one carbon atom of the diamond with the larger silicon atom, which causes the two carbon atoms on either side of the silicon atom to feel crowded enough to flee. That leaves the silicon atom a kind of large landowner, buffered against stray electrical currents by the neighboring non-conducting vacancies.

Although the silicon atoms are embedded in a solid, they behave as though floating in a gas, and therefore their electrons' response to quantum stimuli are not clouded by unwanted interactions with other matter.

The silicon atoms have been implanted exactly where the researchers want them, which allowed them to create thousands of implanted locations. All of these yield working quantum devices because the atoms are planted well below the surface of the substrate and annealed in place.

Before this, researchers had to search for emitter atoms among about 1,000 randomly occurring defects — that is, non-carbon atoms — in a diamond substrate of a few microns to find even one that emitted strongly enough to be useful at the single photon level, they noted.

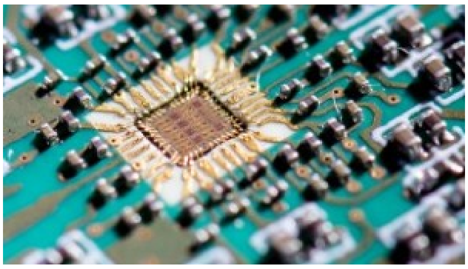
Once the silicon atoms are settled in the diamond substrate, laser-generated photons bump silicon electrons into their next higher atomic energy state. When the electrons return to the lower energy state, because all things seek the lowest possible energy level, they spit out quantized photons that carry information through their frequency, intensity and the polarization of their wave, the team added.

Speeding wireless data rates with pulse-radio technology
Taking a page from radio inventor Guglielmo Marconi, **Rice University** wireless researchers are set to create the first laser-free, wireless system capable of delivering **1 terabit** of data per second.

1 terabit per second would be more than 20,000 times faster than today's top 4G wireless networks and about 20 times faster than the U.S.' speediest home internet services.

Rice University engineering researchers Aydin Babakhani (left) and Edward Knightly are taking a page from the radio inventor Guglielmo Marconi to create the first laser-free, wireless system capable of delivering 1 terabit of data per second. (Source: Rice University)

Edward Knightly, professor and chair of Rice's Department of Electrical and Computer Engineering and principal investigator on a new $1.3 million, three-year grant from the National Science Foundation (NSF) to develop terabit wireless technology said breaking the terabit-per-second barrier with radio will enable an entirely new set of wireless applications and communication paradigms.

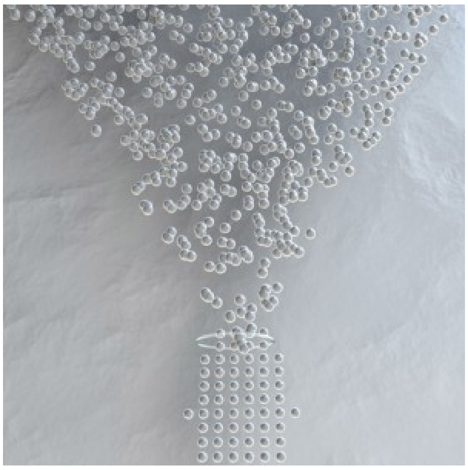


This silicon-germanium chip converts a digital trigger to a 5-picosecond pulse of radiation with a frequency spectrum exceeding 1 terahertz. The chip supports a repetition rate up to 10 gigahertz, provides beam-steering capability and contains a two-by-four array of transmitters with antennas that can each be independently programmed with resolution steps of 300 femtoseconds. (Source: Rice University)

Finding order in the random

Given that scientific discoveries often arise from noticing the unexpected, some **Stanford University** researchers achieved just this while studying a tiny device that has become increasingly important in disease diagnostics and drug discovery, and noticed the surprising way it funneled thousands of water droplets into an orderly single file, squeezing them drop by drop, out the tip of the device. Instead of occurring randomly, the droplets followed a **predictable pattern**, which led graduate student Ya Gai and Sindy K. Y. Tang, an assistant professor of mechanical engineering, to deduce mathematical rules and understand why such rules exist.

The work started with an effort to design tiny devices called microfluidic chips, designed to automate and expedite biomedical research where previously, lab experiments involved using a dropper to deposit biological specimens into a test tube for observation. However, microfluidic devices work much more efficiently: About the size of a postage stamp, they are made of silicone containing many thin channels through which researchers can pump tiny amounts of fluids. The devices allow researchers to place a specimen into a droplet of water surrounded by a thin film of oil. That droplet becomes the test tube. The oily film keeps each droplet and specimen separate.



Stanford mechanical engineer Sindy Tang found order in the seemingly random process of how droplets move through narrow spaces. (Source: Stanford

University)

The microfluidic chips developed in the Tang Lab can create millions of these specimen-bearing droplets quickly. The steadily streaming droplets are ultimately funneled in single file past an instrument that peers at the specimen inside the droplet.

While studying the flow physics of the droplets in the funnel, they observed that — contrary to their expectations — the droplets juggle past each other in a very orderly manner as they squeeze from the wide end to the narrow end of the funnel, which can fit only one drop at a time.

Beyond the immediate relevance to microfluidics, the researchers believe the findings could one day be applied to forming nanocrystals into precise shapes.

TAGS: DIAMOND MATRIX | HARVARD UNIVERSITY | MARCONI | QUANTUM COMPUTING | RICE UNIVERSITY | SANDIA NATIONAL LABS | WIRELESS DATA RATE

Ann Steffora Mutschler (all posts)

Ann Steffora Mutschler is executive editor at Semiconductor Engineering.

Leave a Reply

Comment

Name *

Email *

Website

Post Comment

Overall site

Search

NEWSLETTER SIGNUP

Email:

Interests:

- [ ] System-Level Design
- [ ] Low Power-High Performance
- [ ] Manufacturing & Process Tech
- [ ] Packaging, Test & Materials
- [ ] IoT, Security & Automotive

Subscribe