Faster signal storage and optical processing in nanomachined devices edge closer to realization

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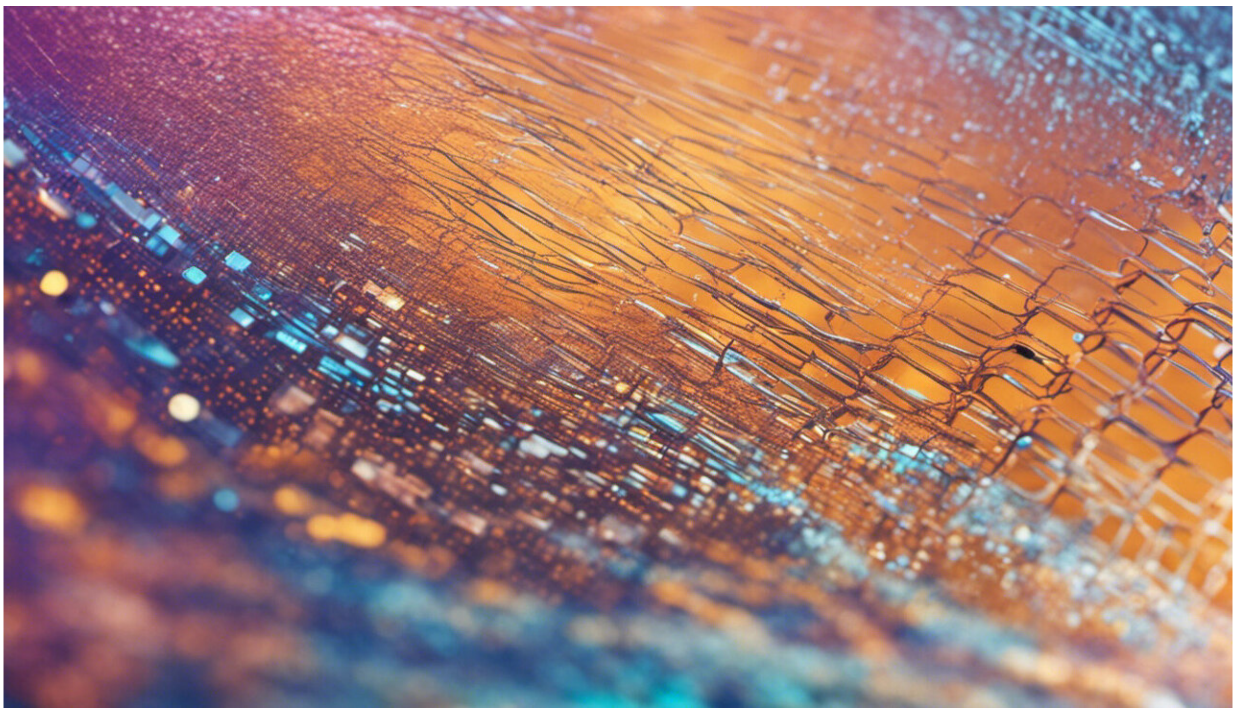

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A system that has only two possible stable states, such as a light switch, is called bistable by scientists and engineers. Bistability in microscale devices could pave the way to compact optical switching and memory elements. In the bistable systems found so far, however, switching between states takes too long to make the approach practical. Now, thanks to the recent observation of bistability in an array of micrometer-sized rings, fast microscale optical switches in novel photonic devices are a step closer to development.

Yefeng Yu of the A*STAR Data Storage Institute and his co-workers in Singapore and France observed this bistability in a device consisting of two 60-micrometer-wide silicon rings into which they could feed laser light of wavelengths specific to the particular ring geometry they used. One segment of each ring hung above a gap, and these free-hanging arcs deformed slightly as light flowed through the ring. The deformation of the rings, in turn, changed their optical properties. As a result of this interplay between optical and mechanical forces, the researchers observed stable behavior at two wavelengths of the light; not at one, as expected. By changing the wavelength of the incoming light, Yu and co-workers could conveniently switch between these two states.

"To our knowledge, this is the first time that optical bistability has been induced by optical forces acting on mechanical motion," explains Yu. "Similar phenomena are usually produced by thermal effects." Relying on heating mechanisms, however, means that the typical times required to switch between the two stable states are relatively long, on the order of milliseconds. Using optical effects gave Yu and his co-workers a much faster means to control the switching process. "The switching time in our system is currently at the microsecond level," says Yu. "But there is some space for reducing this time through design optimization."

This thousand-fold acceleration should assist practical applications. The two stable states of the system, for example, can be used to encode information in terms of 'zeros' and 'ones', as it is in digital computers. But instead of using electrons to process information, the two states of Yu and his co-workers' optomechanical device should allow the representation of information.

"We envisage using our new system to implement optical logic gates for data processing," Yu says. But there may be many more possible uses for these devices. "Applications we want to explore include tunable lasers, biosensor and optomechanical memories."

More information: Yu, Y. F., Zhang, J. B., Bourouina, T. & Liu A. Q. Optical-force-induced bistability in nanomachined ring resonator systems. *Applied Physics Letters* 100, 093108 (2012). dx.doi.org/10.1063/1.3690955

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