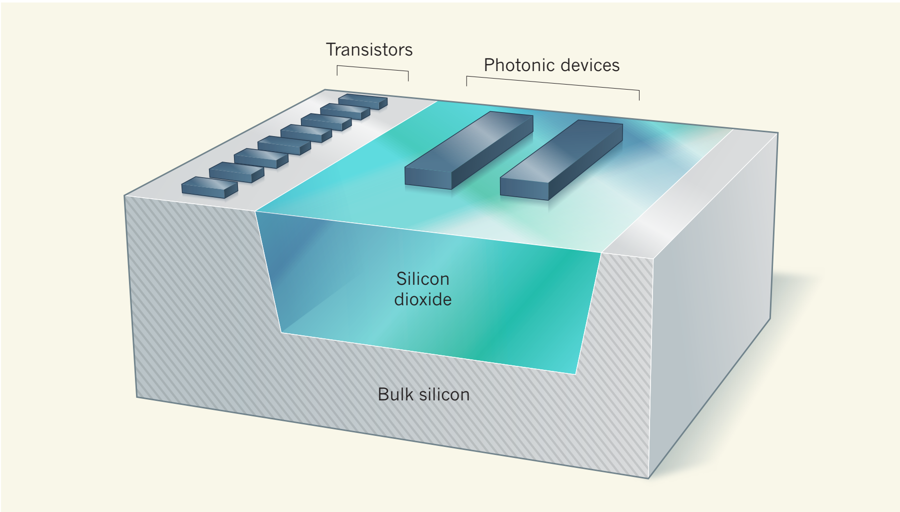

Figure 1 | Optoelectronic integration. Atabaki *et al.*[1] report a technique for integrating electronic and photonic devices on a single silicon microchip. The authors added isolated patches (islands) of the insulator material silicon dioxide to a bulk silicon substrate — for simplicity, a single island is shown here. They then deposited a thin film of polycrystalline silicon on top. Photonic devices and electronic devices known as transistors were fabricated from this film; the former in the silicon-on-insulator region and the latter in the bulk silicon. (Adapted from Fig. 1b of ref. 1.)

top. Photonic devices were fabricated in this silicon-on-insulator region, whereas transistors were formed in standard bulk silicon regions on the CMOS chip (Fig. 1).

Although the electronic and photonic properties of crystalline silicon are superior to those of polycrystalline silicon, because the former has a more uniform structure, it is not possible to grow crystalline silicon on top of silicon dioxide. Atabaki *et al.* therefore opted for polycrystalline silicon, which is relatively cheap and readily available because it is used in transistor fabrication. The authors used this material to create various photonic components, including waveguides (structures that enable light propagation on chips), optical filters known as micro-ring resonators, vertical grating couplers (for coupling light between waveguides and optical fibres), high-speed modulators and photodetectors.

The performance of these components was similar to or better than previous demonstrations in polycrystalline silicon[7–9]. But, more importantly, the performance was unaffected by the fact that such components operated next to electronic-circuit blocks composed of millions of CMOS transistors. Consequently, the authors' silicon-photonics chips can achieve many of the goals of systems that require multiple chips, with substantial cost, scalability and performance advantages.

Atabaki and colleagues' results are impressive, but there are several aspects that could be improved. For example, optical loss in the waveguides could be reduced, and the filtering of light in the micro-ring resonators and the coupling efficiency of the vertical grating couplers could be increased. The authors suggest that optical loss might be minimized by refining the polishing process that they used to reduce the roughness of the silicon dioxide islands and the polycrystalline-silicon film. Such an improvement would lead to chips that have better photodetector sensitivity, lower voltage requirements and lower power consumption — all of which are crucial for the realization of efficient on-chip optoelectronic systems.

Further optimization of the polycrystalline-silicon film could enhance the speed of the modulators and photodetectors, which is paramount for future optical connections that can transmit data at rates of multi-terabytes per second. Atabaki *et al.* fabricated their silicon photonics chips using a technology based on 65-nanometre transistors, and it will be interesting to see whether their approach can be extended to smaller scales at which an even greater density of transistors can be integrated. Future work could also examine how the approach could be used for optical connections inside microprocessors.

Although there are several challenges to be overcome, the authors' work is a milestone on the path towards the mass production of on-chip optoelectronic systems. We can expect an exciting period of development of such systems, and their demonstration for a host of applications. In the future, they might be as ubiquitous as today's electronic microchips. ■

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50 Years Ago

A modern approach to the study of salmon migration has been started … The project involves the use of a computer in a three year analysis of the factors involved in the migration of salmon to fresh-water rivers and those which might affect the fish on its return to the sea. The analysis appears to be the first of its kind in Europe and possibly in the world … Data from a number of rivers will be fed into the computer at intervals of about a month. Physical factors which may be connected with the movement of salmon are being recorded, particularly river flow, air and water temperature, amount of light … and solar radiation … In addition, special fish traps record all the fish swimming up or down the river.
From *Nature* 20 April 1968

100 Years Ago

The possibility of an aerial mail has often been commented upon … and it is very interesting to note that a company has actually been formed in Norway for the purpose of establishing a mail service between Aberdeen and Stavanger. This trip was made just before war broke out … in about five hours' flying, and it is estimated that the mail services will reduce this to four and a half hours with modern machines. An extension of the system to Christiania and Copenhagen is contemplated, and it is hoped that letters leaving Aberdeen in the morning would be delivered in both these cities in the afternoon … The value of such a mail service would be very great at a time when the oversea service is so seriously hampered by the German submarine campaign, and the satisfactory establishment of the contemplated Norwegian service would undoubtedly soon lead to a general use of the aeroplane for rapid international communication.
From *Nature* 18 April 1918