of input to output emission (typically defined as the fraction of the spontaneous emission that goes into the cavity mode, or β factor[6–8]) is $\beta = 0.19$, meaning that only 19% of the spontaneous emission goes into the cavity mode. Although this might not be a big number, it is already comparable to some of the best photonic-crystal-based nanolasers embedded with quantum dots[9]. The measured peak output power was found to be 10 fW at an incident pump power of 100 nW.

Engineering efforts should lead to improvements in the output power and the operational temperature of Xu and collaborators' nanolaser. These could involve suitable transition metal dichalcogenides that emit at wavelengths compatible with silicon photonics and that achieve lasing under electrical injection. A bigger challenge would be the understanding of the fundamental aspects of the laser, such as its coherence properties and photon statistics. This is important to substantiate the true lasing characteristics of nanolasers and to help improve future laser designs and performance.

Xu and colleagues' work along with other recent demonstrations of single-photon emission from defect states in 2D materials[10,11], of the formation of room-temperature polaritons[5] and of enhanced spontaneous emission[2–4], will surely stimulate further research activity on devices that incorporate 2D materials in or in contact with photonic structures such as micro- and nanocavities. Because of their inherently strong interaction with light, and other attractive properties such as valley polarization and strong spin–orbit coupling, 2D materials could open up avenues for the development of heretofore inaccessible device features with potential applications in classical and quantum photonics. ❐

Vinod Menon is in the Department of Physics, City College & Graduate Centre, City University of New York, New York, New York 10031, USA.
e-mail: vmenon@ccny.cuny.edu

References

1. Wu, S. *et al. Nature* http://dx.doi.org/10.1038/nature14290 (2015).
2. Gan, X. *et al. Appl. Phys. Lett.* **103,** 181119 (2013).
3. Wu, S. *et al. 2D Mater.* **1,** 011001 (2014).
4. Schwarz, S. *et al. Nano Lett.* **14,** 7003–7008 (2014).
5. Liu, X. *et al. Nature Photon.* **9,** 30–34 (2015).
6. Chow, W. W., Jhanke, F. & Gies, C. *Light Sci. Appl.* **3,** e201 (2014).
7. Khajavikhan, M. *et al. Nature* **482,** 204–207 (2012).
8. Strauf, S. & Jahnke, F. *Laser Photon. Rev.* **5,** 607–633 (2011).
9. Ellis, B. *et al. Nature Photon.* **5,** 297–300 (2011).
10. Srivastava, A. *et al.* Preprint at http://arXiv.org/abs/1411.0025 (2014).
11. He, Y.-M. *et al.* Preprint at http://arXiv.org/abs/1411.2449 (2014).

Published online: 16 March 2015

MATERIAL WITNESS

THE TURING TOUCH TEST

All the while Domhnall Gleeson's Caleb is supposedly conducting a Turing test on Ava, the humanoid robot of Alex Garland's movie *Ex Machina*, he never touches her once. Her inventor Nathan is taking rather too much for granted there. True, until Ava is fully clothed and bewigged there is no mistaking, from the filigree mesh covering her limbs and torso, that she is a manufactured being. But to pass as a real human, as she would need to when at the movie's end she is out in the world, Ava should also 'feel' human too. And it is hard to imagine how a mechanical body, no matter how exquisitely made, could ever fool us into thinking we are touching a human quickened and warmed by the pulse of life.

Yet today there is more reason than ever to face that challenge. A few people worldwide who have lost limbs have been fitted with prosthetic replacements that can be controlled by their mind, using signals from their nerve endings connected to electrodes[1]. The technology, developed at the Rehabilitation Institute of Chicago, makes use of a surgical technique called targeted reinnervation[2]. Right now recovery of limb function is obviously the priority, but at some point it may well be thought desirable for the limb not only to function as but to look and feel like a wholly real one, to both the user and others. Learning to live with prosthetic limbs carries a whole range of psychological issues concerning a sense of 'body ownership' and feelings of social stigma: for example, an ability to conceal prosthesis use typically aids the person's sense of social integration and reduces potential emotional problems[3].

Cabibihan *et al.* now report that with a good choice of materials, an artificial hand can be made to feel indistinguishable from a human hand when it touches subjects[4]. Selection of the best material for 'synthetic skin' was made by participants who were offered a choice of four different soft polymeric materials, all of them used previously for prosthetic or robotic applications, heated electronically to different temperatures. The subjects showed a clear preference for two of the materials, silicones with trade names Ecoflex and Prochima, and the preferred average temperature was 28.4 °C, close to the measured average of the participants' own fingertips.

Cabibihan *et al.* then made an artificial hand from the Ecoflex silicone moulded over a resin replica of a human hand skeleton made by 3D printing. Their indentation measurements showed that it had rather similar skin compliance to a real hand over much of the surface. Participants were tested to see if they could distinguish the feel of the optimally warmed artificial hand from that of a real hand when touched on the forearm while the hand was kept hidden from them. The differences were barely significant, especially in terms of judgements about whether the hand was 'certainly' prosthetic. It would be fair to say that this synthetic hand passed the Turing touch test. ❐

PHILIP BALL

References

1. Aszmann, O. C. *et al. Lancet* http://dx.doi.org/10.1016/S0140-6736(14)61776-1 (2015).
2. Kuiken, T. A., Marasco, P. D., Loick, B. A., Harden, R. N. & Dewald, J. P. A. *Proc. Natl Acad. Sci. USA* **104,** 20061–20066 (2007).
3. Murray, C. D. *J. Health Psychol.* **10,** 425–441 (2005).
4. Cabibihan, J. J., Joshi, D., Srinivasa, Y. M., Chan, M. A. & Muruganantham, A. *IEEE Trans. Neur. Syst. Rehabilitat. Eng.* http://dx.doi.org/10.1109/TNSRE.2014.2360533 (2014).