and the subsequent lifting off of 1-nm-thick nickel (this thickness was chosen for simplicity — in principle, half a monolayer is sufficient for selective epitaxial growth). The ultra-thin nickel patterns were then oxidized in air to become ultra-thin nickel oxide templates. The patterned substrates were annealed to clean the surface before growing Cu(5 nm)/Ni(5 nm)/Cu(70 nm)/Co(1.8 nm) films at room temperature. The Cu/Co films are used as an underlayer[5] to promote epitaxial nickel growth on the substrate, with 5-nm-thick nickel displaying a stable perpendicular magnetization[3,6]. Films grown on the NiO templates are polycrystalline, whereas those grown directly onto the GaAs surface are single-crystal films. We examined the sample surface by atomic-force microscopy, which yielded roughness parameters in a similar range to that of epitaxial continuous Cu/Ni/Cu films[4].

The modulated magnetic structures were confirmed by magnetic-force microscopy (MFM) and magneto-optic Kerr-effect (MOKE) magnetometry. Figure 1b shows the MFM images of the dot and wire samples in the remanent state after saturation with a perpendicular field. The bright stripes in the images correspond to the out-of-plane nickel magnetization, which has a strong magnetic signal compared with that of the in-plane magnetization.

Figure 1c shows MOKE measurements in the field-perpendicular-to-film (polar) geometry. The perfectly square hysteresis loop obtained from the unpatterned epitaxial film indicates that only perpendicular magnetization exists (Fig. 1c, left). For the wire sample, however, the sharp switch at low field originates from the regions of perpendicular magnetization (Fig. 1c, right), whereas the gradual saturation in high field is caused by the presence of the in-plane magnetized regions.

The spin-engineering of this magnetic medium, which can be seen as the integration of patterned features into chemically homogeneous films, opens up new avenues for controlling the spin structure of magnetic materials. Our simulation results show that the patterned bit resolution can be smaller than 30 nm. Such modulated structures can be used as planar patterned magnetic media[7] without breaking the homogeneity of the magnetic film, which is essential for avoiding effects caused by reduced Curie temperature. Furthermore, the anisotropy-constrained magnetic walls are static in nature, which provides a reproducible switching mechanism, unlike that of the natural domain wall. Such a system could also be useful for studying magnetic dipolar and exchange interactions, for example, and domain-wall resistance in highly controlled geometric systems.

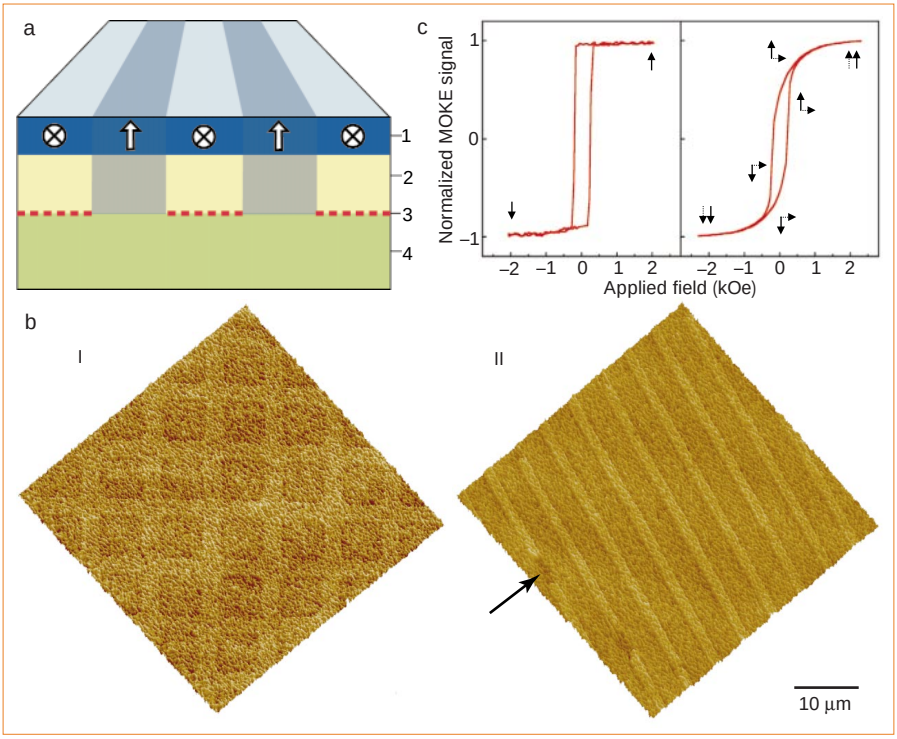

Figure 1 Selective epitaxy in spin engineering and magnetic characterization. **a,** Selective epitaxial growth of Cu/Ni/Cu/Co structure. Layer 1, magnetic layer of nickel; symbols: crosses, magnetization in the plane of the film; arrows: magnetization perpendicular to the film. Layer 2, Cu/Co underlayer. Ultra-thin NiO was used as the embedded template (layer 3) on a GaAs(001) substrate (layer 4). The wire arrays are 2 μm wide and separated by 4 μm; the square dots are 7×7 μm^2 and are separated by 3 μm. **b,** Magnetic-force microscopy (MFM) images of the dot (I) and wire (II) samples in zero field after perpendicular field saturation. Arrow indicates a switch of the perpendicular Ni induced by the external stray field of the MFM tip. **c,** Polar magneto-optic Kerr-effect (MOKE) hysteresis loops for the unpatterned reference sample (left panel) and the wire sample (right panel). Solid and dotted arrows indicate the magnetization orientation in the epitaxial and polycrystalline regions, respectively, of the Ni film.

S. P. Li*, W. S. Lew*, J. A. C. Bland*, L. Lopez-Diaz*, M. Natali†, C. A. F. Vaz*, Y. Chen†

**Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge CB3 0HE, UK*
e-mail: jacb1@phy.cam.ac.uk
†Laboratoire de Microstructures et de Microélectronique (CNRS), 196 Avenue Henri Ravera, 92225 Bagneux Cedex, France

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COMMUNICATIONS ARISING

Ecology

Is coral bleaching really adaptive?

From an experiment in which corals are transplanted between two depths on a Panamanian coral reef, Baker[1] infers that bleaching may sometimes help reef corals to survive environmental change. Although Baker's results hint at further mechanisms by which reef-building corals may acclimatize to changing light conditions, we do not consider that the evidence supports his inference[1].

Baker's study attempts to test the 'adaptive bleaching hypothesis'[2] (ABH), in which stressed corals first lose their dinoflagellate symbionts (bleach) and then regain a new mix of symbionts that are better suited to the imposed stress regime[3]. Bleaching in response to increased, and not decreased, irradiance is well known[4], and Baker's corals suffered more bleaching when transferred to the shallow site. However, their mortality was lower and their mix of symbiont genotypes was altered, unlike those corals that were transplanted to the deeper site, leading Baker to conclude that the higher mortality of the latter corals was due to their failure to bleach and hence to vary their symbiont genotypes.

We are concerned not only that Baker uses undefined stresses, which do not specifically include temperature (thought to be the primary cause of mass coral bleaching[5]), but also that the corals in his treatments recover under very different conditions. The corals classified as "chronically stressed" recovered at the relatively low-light, deep-water site (20–23 m),

where the only two species that showed increased mortality at depth (*Diploria strigosa* and *Acropora cervicornis*) were very rare. Baker's "acutely stressed" corals, however, recovered under the higher light levels of a shallow-water site (2–4 m). From this experimental design, we cannot unequivocally conclude that the improved survival of the acutely stressed corals was due to their adoption of a new mix of dinoflagellates after bleaching, or to improved recovery conditions at the shallow site. As light energy is critical to the survival of reef-building corals[6], stressed corals might be expected to survive better when transplanted to a more sunlit site and less well after transfer to deep water, irrespective of bleaching.

The ABH assumes that bleached corals favour new host–symbiont associations that optimize survival, necessitating rapid evolutionary adaptation (that is, genetic change) by populations of reef-building corals and their symbionts[3]. Although Baker claims that bleaching offers an ecological opportunity for reef corals to rid themselves rapidly of suboptimal algae and to acquire new partners[1], he relies on a molecular technique that is unable to distinguish newly invading genotypes from other rare genotypes that are already present in the host and which simply increase in proportion after conditions change. The latter is a phenotypic change (acclimatization) and, as such, is restricted in its provision of new genetic combinations for evolution.

We consider that the evidence in favour of the ABH remains scant in the absence of observations that the genotypes of symbionts in corals become more thermally robust during and after mass bleaching. Baker's finding that corals adopt a different mix of symbiont genotypes when moved from one light environment to another is an interesting addition to the well-known acclimatory responses of corals and their symbionts to changes in light quality and quantity[7], but we cannot conclude that bleaching favours new host–symbiont combinations that guard populations of corals against rising sea temperature.

Ove Hoegh-Guldberg, Ross J. Jones, Selina Ward, William K. Loh
Centre for Marine Studies, University of Queensland, Queensland 4072, Australia
e-mail: oveh@uq.edu.au

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Baker replies — Hoegh-Guldberg *et al.* suggest that corals that were transplanted downwards died more frequently than those transplanted upwards because they were deprived of critical sunlight energy at depth. My argument went a step further by explaining why this energy is so critical for these transplanted colonies.

Because corals that were transplanted downwards did not bleach in response to reduced irradiance, they failed to exchange their 'high-light' algal symbionts for the more suitable 'low-light' algae that were already found in the deep-water colonies at this site (and/or at other sites nearby). As a result, they contained inappropriate algae for their new environment, which led to chronic stress and eventual mortality.

In contrast, corals that were transplanted upwards experienced severe bleaching as a result of increased irradiance. Consequently, suboptimal low-light algae were removed, allowing high-light algae to become dominant in the newly vacant hosts. Such corals survived well as a result, despite their initial bleaching. This explanation is particularly powerful because it unifies coral bleaching, symbiont change and host mortality.

Hoegh-Guldberg *et al.* suggest that my findings fail to support the ABH because they do not provide evidence of 'new' symbionts in transplanted corals. The ABH is not limited to this constraint. Regardless of the origin of replacement symbionts (which, as I pointed out, may "colonize" and/or "proliferate inside" hosts) or the proximate environmental causes of bleaching (for example, light or temperature), if bleached reef corals change the composition of their symbiont communities faster than unbleached corals, and if more rapid symbiont change proves beneficial, then bleaching has adaptive value. Even if adult colonies are unable to form symbioses with unusual or new algae (which is unlikely, given the recent discovery of some scleractinian coral colonies containing symbionts that are usually found in foraminifera[1]), cryptic populations of diverse symbionts may still occur at low abundance in many coral hosts[2].

There is no field evidence that symbiont genotypes change after bleaching events because the necessary molecular investigations have not yet been undertaken. Despite this, one of the best available long-term data sets on mass coral bleaching and mortality reveals that far fewer corals in the far-eastern Pacific Ocean died after the 1997–98 El Niño event (0–26%) than after the 1982–83 El Niño event (52–97%; ref. 3), even though the magnitude and duration of sea-surface temperature anomalies in the region in 1997–98 exceeded those of 1982–83 (ref. 4). These observations indicate that surviving reef corals may be more resistant to recurrent thermal stress through having experienced earlier episodes of severe bleaching and mortality, as predicted by models of symbiont change[5].

Furthermore, field experiments with bleached corals[6] and laboratory studies of model invertebrate–algal symbioses[7] support some of the assumptions of the ABH. We should not mistake an absence of evidence for evidence of absence, and instead need to document worldwide patterns of coral–algal associations and their response to mass-bleaching events. The real question is not whether coral–algal associations can adapt by recombining, but rather how, and over what timescales, they do so.

Although episodes of mass coral bleaching and mortality will occur in the future, my findings suggest that they may not recur with the frequency and severity predicted by some studies[8]. This should stimulate efforts to protect the remaining three-quarters of the world's coral-reef ecosystems[9] by reducing the compounding effects of anthropogenic factors that are still under our influence.

Andrew C. Baker*†
**Marine Conservation Programs, Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, New York 10460, USA*
†Center for Environmental Research and Conservation, Columbia University, New York 10027, USA
e-mail: abaker@wcs.org

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errata

Seeing through the face of deception

I. Pavlidis, N. L. Eberhardt, J. A. Levine
Nature **415,** 35 (2002)

It was not intended to convey the impression that this thermal-imaging technique is already suitable for mass security-screening purposes: indeed, the false-positive rate identified in this small study might preclude large-scale application.

Laterality in tool manufacture by crows

Gavin R. Hunt, Michael C. Corballis, Russell D. Gray
Nature **414,** 707 (2001)

The tool held in the beak of the bird shown in Fig. 1 of this communication was wrongly described as a crochet tool, whereas it is a simple leaf-stem tool that happens to be hooked.