Evans and colleagues covalently attached a polydimethylsiloxane or polyethyleneoxide oligomer tail to spirooxazine, chromene and azo dyes and then dispersed them in a rigid polymer solid[3]. Their idea was to change the environment around the dye from a hard-walled chamber to a softer space formed by the spontaneous coiling of the low-viscosity oligomer around the dye, as illustrated in Fig. 1b. This molecular-cushion approach greatly increased the fading speed in the polymer matrix. Discolouration occurred as smoothly as in solution, even though the polymer matrix was highly crosslinked. The effect was particularly remarkable for dyes containing a polydimethylsiloxane tail. (The better flexibility of the polysiloxane chain is easily predicted considering that a polydimethylsiloxane of molecular weight of about 10^3 is a liquid with a low viscosity, whereas a polyethyleneoxide of almost the same molecular weight is a waxy solid.)

On top of this exceptional enhancement in the photochromic properties, the authors also note that their chemical modification of the dyes also offers a practical advantage. Because the physical state of the dyes changes from crystalline solids to oils or viscous gums, dissolution and dispersion into the polymer becomes a much easier process.

The present work may attract both fundamental and practical interest. The shape change of a photochromic molecule incorporated in a polymer solid should lead to a distortion of both main and side polymer chains surrounding the guest molecule. However, there has been only scarce knowledge on guest-induced structural changes of host polymer matrices. Comparative studies on isomerization behaviour of photochromic molecules with and without a flexible long chain in a polymer solid may give a clue to resolving this question. The practical significance comes from improving performances of polymer-based photochromic materials. It will be interesting to see whether this approach will be effective in improving the performances of photochromic materials for rewritable memory or optical switching (that is, fulgides[4] and diarylethenes[5]), which follow a photochemical rather than thermal pathway to discolouration.

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MATERIAL WITNESS

A change for the better?

It's not easy to sum up what Massive Change, a project launched by Bruce Mau Design in Toronto, is all about. Try this: "Massive Change is about the power and promise of design … to meet human needs the world over." Or this: "Massive Change is not about the world of design; it's about the design of the world." Or perhaps you should just go along to the Toronto Art Gallery in Ontario, where the Massive Change exhibition appears until 29 May 2005, and see for yourself.

Failing that, read the book. *Massive Change* (Phaidon, 2004) offers a series of bold, seemingly utopian claims: "We will create urban shelter for the entire world population", "We will bring energy to the entire world", "We will design evolution." ('We' is, I think, here intended in a global sense — Bruce Mau is not claiming personally to have all the solutions yet.)

Clearly, Massive Change is an ambitious and unrelentingly optimistic project. But its architects insist that it is not utopian — "it is about what is already happening". The aim, perhaps, is to present a possible goal, an outline of what might be achievable if we decide we want it enough.

Although many of these goals have an obvious scientific base, one of the few scientific disciplines mentioned explicitly as a key component of Massive Change is materials science. According to the Materials Economies section of the book, "We will build intelligence into materials and liberate form from matter."

The book celebrates today's 'super' materials: superhard (such as chemical-vapour-deposited diamond films), superstrong (synthetic spider silks), superlight (aerogels), supersmall (the inevitable products of nanotechnology) and supersmart (shape-memory alloys, self-healing plastics). The more versatile our materials, the more freedom they give the designer from the constraints of the standard rulebook: structures become skimpier, materials become adaptive machines, failure and repair are no longer an issue.

Materials science is also at the heart of Massive Change's view of manufacturing: "We will eliminate the need for raw material and banish all waste." Those are not claims to please the purist, who will point out both that you have to start somewhere and that you can't evade thermodynamics. And it is hard to know whether nature's apparently ideal model of materials processing can truly serve for decidedly non-natural products (such as high-performance alloys) or on economically viable timescales.

But Massive Change is surely right to flag the trends towards atom economy, soft and biomimetic processing, and industrial ecology.

To this extent, Massive Change is probably not saying anything that the materials community has not recognized or explored for the past decade or more. But it is good to see these trends presented on a broader canvas encompassing economics, geopolitics and demographics. And it is nice to see an optimistic vision that embraces rather than demonizes technology. The challenge is how to avoid this becoming the 21st-century equivalent of the gee-whiz science and technology fairs of the 1930s — a dream soured by the harsh realities of the corporate and political worlds.

Philip Ball