Biomimetics

Electronic skin

Emma Dorey

Human skin is an interface between a person and the environment, so researchers are developing thin, flexible substrates that mimic some of its properties, enabling new forms of human-machine interfacing.

US researchers at the University of California, Berkeley, are working on electronic-skin (e-skin) consisting of mechanically flexible sensor networks that can spatially map and quantify various stimuli. They have developed an e-skin that lights up when touched. The skin comprises a matrix of organic light-emitting diodes (OLEDs) on a flexible, conductive rubber substrate that, when compressed, allows electric current to flow. The OLEDs are turned on locally where the surface is touched; the intensity of the light emitted is controlled by the force applied to each diode: the harder the push, the brighter the display (*Nature Materials*, doi: 10.1038/nmat3711).

'The key new feature, as compared with our previous work, is that we have made the 'skin' interactive by monolithically integrating an OLED display that is integrated with the underlying sensors and electronics,' explains one of the researchers Ali Javey. 'Where the surface is touched, it lights up with the brightness quantifying the magnitude of pressure.'

Until now, research on e-skin has focused on pressure sensors interfaced with an electronic readout. This is the first e-skin that not only spatially maps the applied pressure but also provides an instantaneous visual response, without the need for external connections.

The flexible plastic substrate that forms the base of the integrated sensor-and-display device can be wrapped around curved surfaces. 'Our vision for e-skin is beyond just robotic or prosthetic applications,' according to Javey, who says that it may find a wide range of applications in interactive input/control devices, smart wallpapers, robotics and medical/health monitoring devices.

'The challenge for the proposed e-skin is finding applications that fit its characteristics,' says Chris Atkeson, a professor in the Robotics Institute and Human-Computer Interaction Institute at Carnegie Mellon University, US. While the e-skin is probably not tough enough for the wear and tear of robot skin, he says, there are applications where the visual feedback of the proposed e-skin might be useful, such as shoe fitting, dental bite pattern measurement and mattress selection.

'However, it is not clear that having the skin provide the image directly is all that useful, as one's foot or body is in the way, and one would have to use a camera or mirror to see into one's mouth,' says Atkeson. 'A futuristic application of artificial skin is covering all the surfaces that humans interact with, such as floors, walls and furniture. Once the world is force sensitive, new applications will be created we can't anticipate.'

Paul Hodges
chairman, International eChem

Fair play at work

If you enter a UK office or factory today, you will probably find many women in senior positions. But this would have been quite unusual in most businesses even 40 years ago. Until the 1975 Equal Opportunity Act, and the limited introduction of maternity leave in 1978, many women left work when they had children and found it difficult to return at the same level afterwards.

This legislation thus provided major reinforcement for the ground-breaking Equal Pay Act in 1970, which had aimed to force employers to give women equal pay for equal work. But many companies instead tried to evade the law by introducing new pay grades at lower wages, and allocating these almost exclusively to women. Thus, women's pay relative to men between 1970 and 1974 rose only marginally, from 54% to 56%.

But the legal right to stay at work after marriage began to change mindsets. Employers began to accept that women could be interested in developing a career and might target more senior and higher-paying roles. Whilst the legal right to maternity leave meant women could choose to return to their jobs after giving birth, and not have to start at the bottom of the ladder again.

Three statistics demonstrate the scale of the change over the past four decades:

- 75% of women now work, compared with 60% in 1970.
- Women's pay is now 80% of men's, compared with 54% in 1970
- By 2008, average women's pay had risen nearly threefold from £11k in 1970 to £30k/year, in inflation adjusted terms.

From a chemical industry viewpoint, these developments completely changed the nature of demand. Major new markets began to open up. For example, working women with children needed – and could now afford – higher quality labour-saving devices for the home. Even more important was the arrival of the dual-income household for the first time in history.

This meant cars and houses became more affordable, as did all the other consumer products on which chemical demand depends. Household income is 60% of GDP in most western countries, and 71% in the US, so dual-incomes also provided a major boost for the wider economy.

But today, the world is moving in a new direction. The Baby Boomer generation – born between 1946 and 1970 – who pioneered these changes are starting to retire in large numbers. And the continuing financial crisis means that women's pay, like men's, is now falling in real terms. It was 10% below its peak in 2012, at £27k/year.

Chemical companies thus face a two-fold challenge. Firstly, economic growth will no longer be sustained by women's rising incomes. Secondly, demand patterns are changing quite dramatically. Ageing Boomers are causing a surge in the numbers of women – and men – in the 55+ age group. These New Old are already nearly 40% of the adult population, and their needs are quite different from when they were younger.

Companies that fail to adjust quickly to these major changes risk finding future revenue and profit growth increasingly elusive. ●