Sustainable materials technology

A materials response to a changing world

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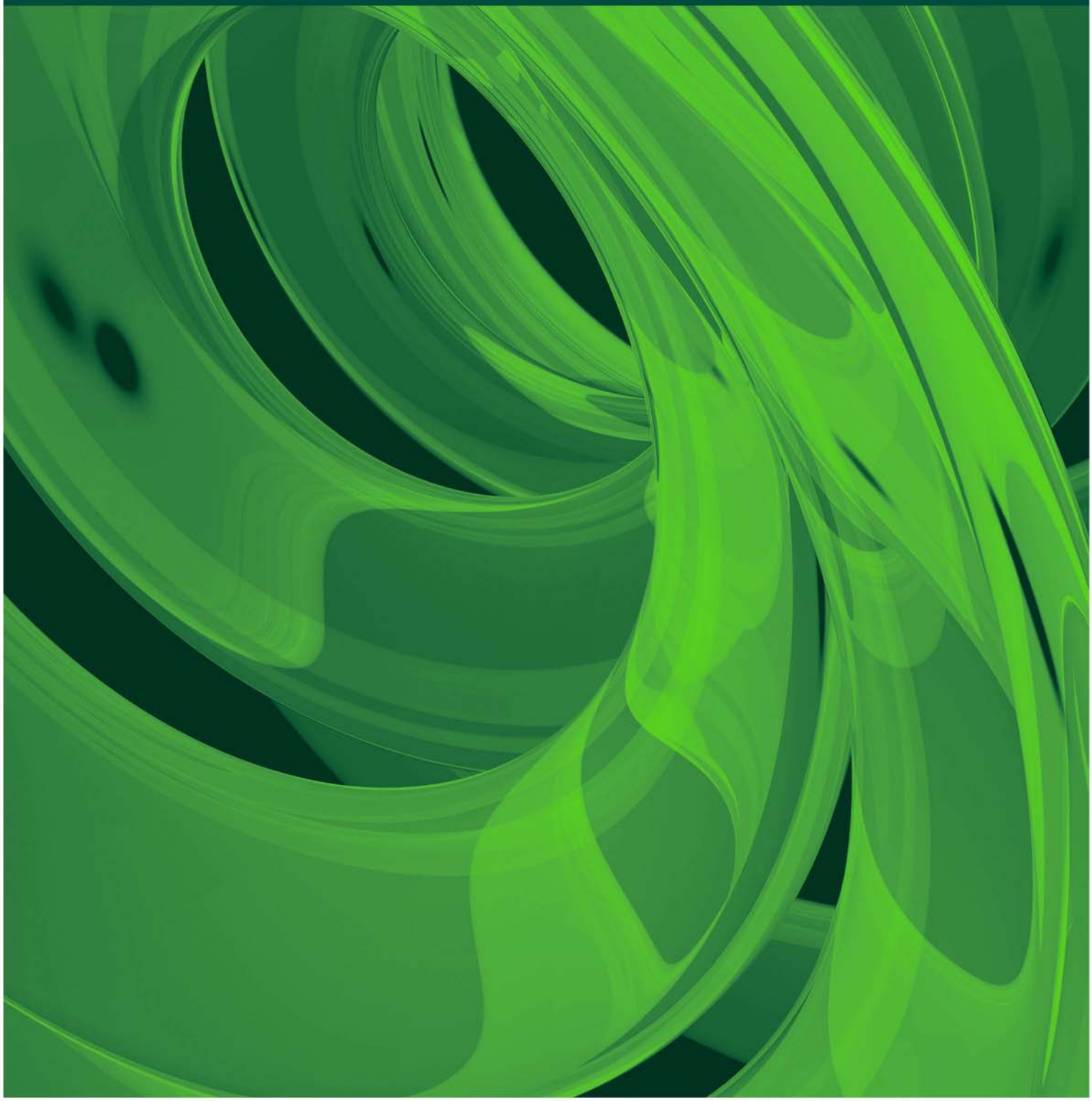
SAGENTIA



Introduction

Sustainability impacts business in many market sectors. Business leaders across the chemicals and materials sector are looking to their business development and technology teams to understand how they can best meet the resulting challenges of sustainable development and achieve commercial advantage.

Responding to these challenges is not straightforward. Furthermore, the level of investment in sustainable materials development remains uncertain. One example of this is the chemicals giant Evonik, who state[1] that R&D spend specifically on 'greener chemistries' has not increased, but rather 'environmental performance' has become a key factor in the selection of research programmes. Studying the Dow Jones Sustainability Index reveals that all the major corporates in the materials sector, including Akzo Nobel, DSM, BASF, Bayer, Dow Chemical, and Süd-Chemie, are now active in developing sustainable materials solutions.

What are the benefits?

To the enlightened materials manufacturer, the benefit of a sustainable focus within their business is not philanthropic; it means the prospect of real commercial and cost advantage.

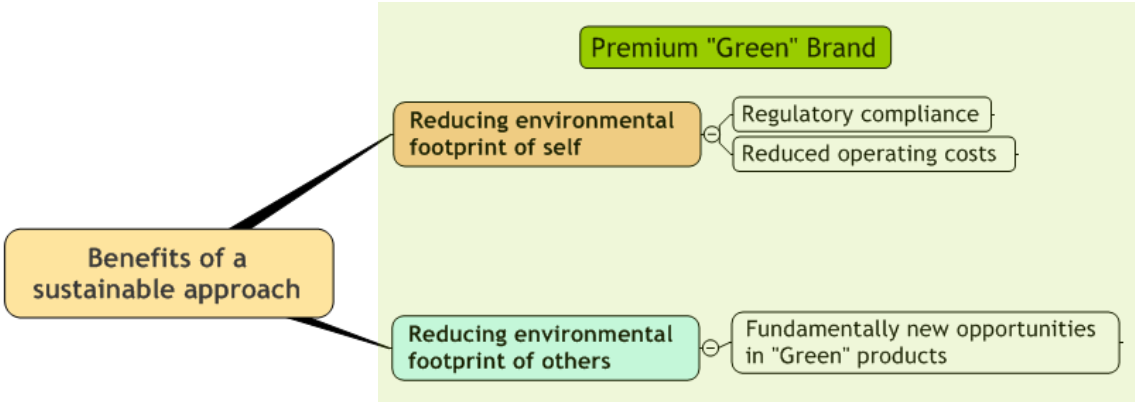


fig.1 Areas of new opportunity created by a sustainability theme

Cynics may claim they have heard this all before – there was a 'green wave' only a decade ago into which many millions of dollars was sunk, often without any appreciable return. However, this time the outlook, based on a few important factors, appears likely to be different; petrochemicals prices are rising and unlikely to decline; environmental regulation (e.g. Registration, Evaluation, Authorisation and Restriction of Chemical substances - REACH) is increasing, and there's a real willingness from the end user to consider the origin of goods purchased and the price paid.

[1] From "Green Chemistry" by Alex Scott in Chemical Week, 24th October 2007.

Reducing your own environmental footprint

A global trend is emerging where consumers are demanding products which use less energy, less non-renewable resource, or which are derived from renewable materials. This trend is aggravated by the impact of rising oil prices. It is clear, therefore, that minimising usage of non-renewable resource and minimising your detrimental effect on the environment should be the first two ports of call on your sustainable quest.

Reduced waste can generally be perceived as reduced cost, particularly in today's environment where significant cost increases for the disposal of waste has encouraged the reuse of waste. In addition, simple recycling of waste, such as paper and inert fillers, has now become the norm – but such approaches generally have only a small effect on the total cost of waste. The greatest costs are generally associated with more reactive and hazardous waste materials. Hence, significant savings can be realised when such a waste material can be reused as a raw material for a secondary application – by using this particular type of waste in this way, an organisation can make a positive contribution to its bottom line. We have found that these particular opportunities are most effectively identified by taking a functionality based approach, where we can marry the properties of waste materials with materials requirements in other sectors.

Looking beyond waste reduction, there are many other routes to developing processes and materials which are more sustainable. These include reducing energy use through process efficiency; use of 'white biotech'; biocatalysis; volatile organic compound (VOC) reduction in process and application (for example using ionic liquids); use of (bio-)renewable feed-stocks, and improved recyclability. Crucially, the development of such approaches is enabling materials suppliers to offer sustainable materials at a price that is comparable to their traditionally sourced analogues.

Traditionally, raw material costs have held back the move to more renewable products. A reason for this is the relatively immature production processes for such materials, which cannot compete with the slick petrochemicals supply chain. Innovation in the use of alternative feedstocks has also been held back by the prospect of wasted investment when petrochemicals prices decline following an oil price spike. However, oil prices are now consistently reaching new highs, and escalating conflict over oil resources adds to price volatility, increasing the difficulty in predicting costs for petrochem-derived materials. A combination of these factors is driving the development of renewable materials to the point were economies of scale can be realised. Polylactic acid, PLA, is an example of this trend, with increasing penetration into packaging applications as materials costs reduce. Leading packaging companies, such as RPC Group, already provide a comprehensive range of biodegradable packaging based on PLA.

However, attempts to force-fit a renewable substitute for a petrochemical analogue can result in poor performance. Hercules' recent bio-adhesive joint venture, H2H, provides an alternative approach. Here, traditional components of an adhesive were replaced by a sustainable version offering similar functionality. This product was inspired by proteins used by ocean mussels to cling to rocks, but the proteins required to produce the adhesive can be conveniently derived from simple soy feedstocks. This demonstrates that new opportunities can result from the evaluation of application requirements and by matching these requirements to functionality delivered by a (renewable) material – an approach we call Functional Analysis. We have used such a methodology to help a major toy maker to switch to natural plastics for injection moulding, and a leading FMCG company to revolutionise air treatment products by replacing the aerosol with an alternative delivery system.

Reducing the environmental footprint of others in the value chain

Another approach to sustainable product development is to focus on how your organisation can support the sustainable behaviour of others – either eventual end users, or intermediates in the value chain. Here, key issues to address are those relating to the manufacture, use, and eventual disposal or recycling of a product. Legislation concerning the recycling or disposal of a product – embodied by the WEEE regulations – has started to roll out across the EU and will place the burden on manufacturers to recycle their products. This makes materials which are difficult to recycle especially unattractive. In turn it also necessitates innovation in order to produce products that can be easily dealt with beyond their lifetime.

To understand the impact of these issues, techniques such as life cycle analysis have proven useful. For example, investigating the embedded energy and carbon footprint inherent to a product is critical to understanding approaches to improving sustainability. This approach has driven automotive companies (for example Audi) to pioneer the use of lightweight structural materials in vehicle manufacture. By using this technique we've uncovered a portfolio of sustainable opportunities for a number of companies in a variety of sectors. Such techniques facilitate intelligent design for a product minimising the carbon footprint over the entire lifecycle.

Supplying materials (for example adhesives, fuels and polymer feedstocks) that can be produced via a low energy process and make use of renewable feedstocks, provides an inherent 'green' premium to an organisation's products. In addition, working closely with customers to understand their own 'green' issues can open up whole new fields of demand for innovative product development. As an example, the novel conductive ceramic manufacturer, Atraverda, makes use of sustainable raw materials and a low energy manufacturing process in the production of its products. However, the key commercial advantage of the product emerged when it became clear that the material could be used to reduce the usage of lead in car batteries, rather than its initial application in water treatment.

In addition to reducing a customer's footprint, materials development can contribute to sustainability by providing functionality that enables new 'green' technologies. These may include alternative energy sources such as fuel cells and photovoltaic modules, or waste remediation technologies such as gas scrubbing or catalytic filters. For example, a key enabler for many of the renewable energy or automotive emission reduction programmes, is the development of high performance rechargeable battery technology. These technologies are dependant on the development of advanced material solutions to provide the performance required, and hence provide a major opportunity for many specialty materials manufacturers. Despite this, picking the right opportunity from the many approaches is far from trivial. In one of our recent programmes, it was clear that identification of major growth opportunities in this area could only be accomplished after a detailed evaluation of emerging technologies, value chains and competitive environments. However, the potential prize is large – in this rapidly developing market, materials level supply opportunities of $10Ms-$100Ms exist.

In summary

The sustainability theme is gaining importance in the minds of business and technology leaders throughout the chemical industry. Too often we see the focus is on the threat that regulation and changing opinion poses to existing business practice, rather than resulting opportunities. However, organisations that position themselves most favourably in the light of this trend and embrace these changes are more likely to

succeed. Such businesses will seek to create new business from the changes just as they might from any disruptive trend.

The payoff from capitalising on these opportunities can be significant. Discovering these opportunities, however, can be extremely difficult, as they often lie wholly or in part in marketplaces unfamiliar to the specialty materials supplier. Therefore choosing the right partner is imperative for success. Sagentia has had success in identifying opportunities for clients in markets that are seen as being environmentally beneficial.

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