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A synergy report on the opportunities for collaboration in the chemical sciences

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Recommended readers of this report

This report is for participants of the Synergy programme and colleagues within their organisation. Technical managers interested in this topic, working in businesses across the polymer supply chain will also benefit from reading this report, to understand our current and future work in this area. This report may also be of interest to academia, government and NGOs working in this area.

Disclaimer

Executive summary

Transitioning the production of polymers in liquid formulations from a ‘take, make, dispose’ model to one that reuses resources and waste (Circular Economy model) could improve the environmental and economic sustainability of these materials. It

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1 Participants

We would like to thank the following organisations for their contributions to this early stage work.

Anglian Water
Biorenewables Development Centre
BP
British Coatings Federation (BCF)
Centre for Ecology and Hydrology
Centre for Process Innovation (CPI)
CustoMem
DEFRA
Durham University
Ellen MacArthur Foundation
Itaconix
Lubrizol
Marine Conservation Society
PRA World Ltd
Sanofi
Syngenta
Synthomer
Thomas Swan
Unilever Research
University of Bath
University of Birmingham
University of Nottingham
University of Surrey

2 Context to this report

2.1 Collaboration to advance the chemical sciences

2.3

4 Methodology

We employed an iterative approach of engaging with our industrial and academic community to better understand PLFs and integrate as many perspectives as

5 Data analysis and conclusions

We considered the following questions to explore opportunities for the chemical sciences to collaborate on this theme:

1. What are the high-level trends and drivers that

5.1.2 Societal and environmental trends

Changes in society and the environment are two key factors that could influence PLFs over the next 25 years. In the 20th century, global population grew by 400%,[19] doubling our material footprint[20] and waste generation in recent years.[21] In addition, greater public concern for the environment is driving our need to reduce our consumption of virgin raw materials and maximise the lifetime of materials we use.

Some sectors, such as cosmetics and personal care, are particularly observing the effects of this. Consumers are increasingly scrutinising ingredients in the products they buy and actively seeking products that contain natural and biodegradable

5.2.2 Technical feasibility

In addition to gaps in knowledge and understanding,

5.3.1 Modification and development of new monomers and polymers

Consumers are increasingly seeking products that are less harmful for the environment. Modifying existing

5.4.1 Research and development

A key theme for chemical science research and development needed for developing sustainable novel polymers is backbone chemistry, which is important for functionality. Investigating ways of developing these backbones from natural or bio-based monomers, like peptides, could create a range of renewable-derived polymers suitable for diverse applications. In addition, polymer backbones could also be key for designing polymers that degrade in di erent environmental conditions. Exploring ways to control degradability could enable the creation of polymers that are stable in formulations in use, but degrade at the end of their life. Literature highlights examples of degradable linkages for polymers in controlled drug release,[29] which could be a good starting point for this research.

Another key research theme that is important to investigate for inducing degradation of polymers is blending them with catalysts. Research on this topic already exists for waste plastics; one example is the application of catalysts to degrade polyethylene used in agricultural waste and household food packaging into hydrocarbons for gasoline.[30]

Another research theme is exploring the potential of capturing polymers from organic and inorganic waste to improve recycling opportunities. One area of potential exploration could be capturing and recovering polymers from wastewater using existing water treatment solutions that capture specific chemicals.

5.4.2 Skills base and funding

Another key enabler is maintaining and expanding the skills set for progressing these opportunities. We require a whole system understanding of technologies, applications and the social needs in order to tackle this challenge. Comprehensive knowledge and understanding is particularly important for limiting negative consequences in other parts of the system. Specific skills that the UK needs to maintain and enhance includes formulation science, polymer chemistry and engineering. Supporting training and skills development in SMEs and leveraging existing schemes discussed in the trends section are particularly important.

In addition to skills, funding at all levels is important for stimulating fundamental and applied research, commercialisation of new technology, process and technology scale up, and the development of open access capability building tools. Developing strong networks and relationships for knowledge sharing is also important. The UK Circular Plastics Network[31] is one example of how the government is raising awareness, encouraging the sharing of best practice and highlighting emerging innovation to address the plastics challenge. Without a range of funding mechanisms available, the community could lose momentum.

7 References

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