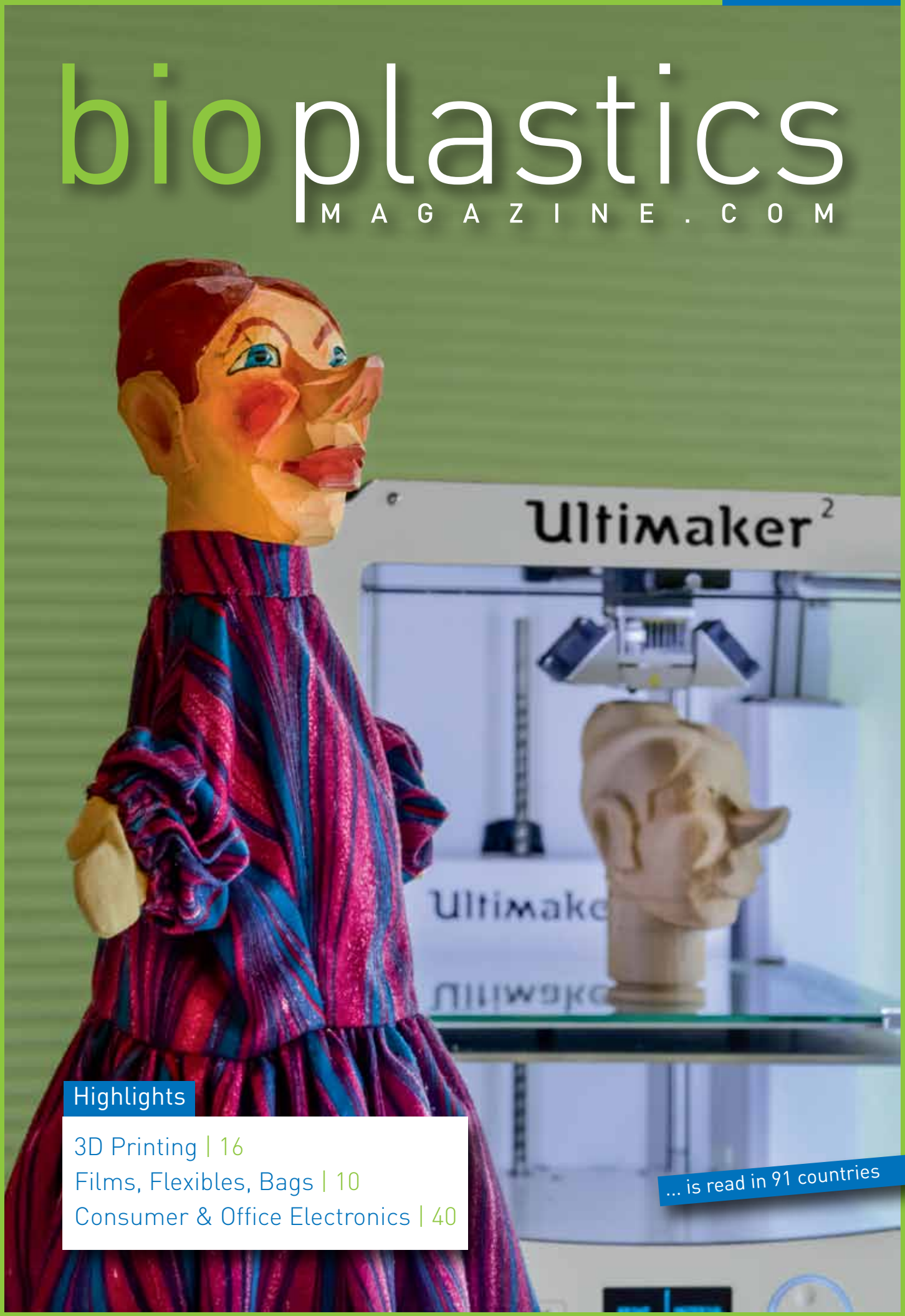
November / December 06 | 2014

ISSN 1862-5258

bioplastics MAGAZINE.COM



Highlights

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bioplastics MAGAZINE Vol. 9

Design challenges with biobased plastics

Biobased plastics, made from renewable resources, are nowadays well-known materials in the packaging industry in many countries. In more durable products though, the application of biobased plastics is still something of a rarity. To stimulate the adoption of biobased plastics in more lasting applications an important role is foreseen for designers. Because designers, both professionals and students, lack a real knowledge of biobased plastics, the CleanTech research programme of the Amsterdam University of Applied Sciences, started a research project focussed on various aspects of designing for and with biobased plastics.

What are the challenges that designers meet?

Although biobased plastics are not new (in fact the first plastics we know were bio-based (cf. bM 04/2014), the current generation of designers and engineers was raised and educated in an era of petrochemical plastics. The renewed attention to biobased plastics only commenced some 15 years ago. Biodegradable biobased plastics, such as PLA and PHA, are often used for packaging purposes. But biobased plastics, whether or not biodegradable, also become a more and more interesting alternative for more durable applications, such as consumer electronics, textiles, automotive parts, toys and sporting goods. Not only the transition towards a biobased and circular economy can be a motive to go biobased (for example with the biobased equivalents of PP, PE and PET), but also new biobased plastics with specific material properties can offer valuable advantages. Until now biobased plastics have not been used for a wide range of applications. Reasons for this are the higher material price, limited feedstock supply and the lack of clarity on biodegradability of both biobased and non-biobased plastics. But ignorance of designers of the unique characteristics and possibilities of biobased plastics is also a reason.

Practical tools to fill the knowledge gap

One of the aims of our research project at the Amsterdam University of Applied Sciences is to provide designers with practical tools to lower the threshold to biobased plastics. Together with students and teachers of the Bachelor of Engineering, the team worked on several cases in which product manufacturers were asked to (re)design a product with biobased plastics. Examples are furniture and products for horticulture. Also new biobased plastics, such as Glycix, made of citric acid and glycerine, were studied by examining their unique properties and by designing and prototyping applications.

Based on these cases and on interviews with designers, producers and product manufacturers three major challenges were identified:

- I do not know a lot about the possibilities of current and upcoming biobased plastics. *How do I know which biobased plastic is suitable for my product?*
- LCA's (Life Cycle Analyses) are very time consuming and lack the data of most biobased plastics. *How can I assess the value, both ecologically and economically, of applying biobased plastics in comparison with alternative materials?*
- It is difficult to distinguish a biobased plastic from petrochemical plastics. *How can I show the consumer that a product is made of a biobased plastic by its design?*

To cope with these challenges three practical tools were developed: a material selection tool, a product quickscan and a set of design rules for the look and feel of biobased plastic products.

Fig. 1 and 2: Prototype tables made with Glycix, a new biobased material developed by the University of Amsterdam.

Fig. 3: Plastics cups, both biobased and petrochemical, that were evaluated in the Look and Feel study.

Bioplastics4U: material selection

Already at the concept stage of a new product, or at the start of a redesign, designers think about material selection. The desired functionality of a product is an important starting point to make a preliminary choice about the material used. Together with Wageningen UR (University and Research centre) a tool was developed that shows designers which bioplastics, both biobased and biodegradable, might be suitable for the manufacture of their new product. By answering 10 simple questions about the desired functionality of the product, the designer gets an indication of which bioplastic fits his application.

The first two questions address to what extend the product should be biobased and/or should it be biodegradable. The next five questions concern properties such as transparency, dimensional stability and mechanical properties. The last three questions relate to the maturity, availability and costs of the materials. The tool shows whether there are bioplastics that meet all criteria or not. It makes designers aware of the choices

they make and the influence these choices have on the available options.

The materials suggested by the tool are only standard grades and were chosen for their distinctive properties. This means that optimisation of the material is possible using specific grades and additives. Material suppliers, compounders and producers can help designers with this next step.

Quickscan: ecological and economical value

The wish to apply biobased plastics often starts from an ecological viewpoint. Designers and marketers often want to know whether the envisioned product, when using biobased plastics, will indeed have less environmental impact than alternatives. Conducting a full Life Cycle Analysis (LCA) is the way to go, but that takes a considerable amount of time and money. Furthermore current databases only contain the data of a very limited number of biobased plastics.

Designers and marketers also want to know what other advantages the application of biobased plastics may give, such as lower life cycle costs, which can be the case with biodegradable plastics or when the material has special characteristics.

Together with Partners for Innovation, a Dutch consultancy on sustainable innovation, a quickscan was developed that assists designers in comparing the new design using biobased plastics with an alternative design. This quickscan contains preliminary data of 10 biobased plastics alternatives, based both on the eco-costs model and on extrapolation of data. Because the designer needs just to fill in the information that deviates from the original design the scan takes only a short time. The quickscan also provides a comparison between the life cycle costs of the biobased design and its alternative. It also assists designers in assessing other advantages of biobased plastics. The first full version of the quickscan is currently being evaluated and will be issued in 2015.

Look and feel of biobased plastics

In some cases it is desirable to make clear that a product is made of biobased plastics. Not by a logo on the product or notification on the packaging, but by the look and feel of the product itself. This is especially relevant when the product is biodegradable or when sustainability is an important element of the company's mission. What design rules can material and product designers use to make sure that their product positively communicates that it is made of a biobased plastic? To develop these design rules an evaluation was made of the way that people perceive biobased plastics in comparison with petrochemical plastics. The team conducted a study in which respondents were asked to assess 10 (non-disposable) cups, either made of petrochemical or biobased plastics. All five senses - look, feel, taste, smell and sound - were tested individually.

Design rules that were derived from this study are for example: *A biobased plastic cup ...*

- has a smooth and soft feel.
- sounds thick, solid and heavy.
- shows a grain, fibre or uneven structure.

Of course these design rules are applicable for cups only and have yet to prove their effectiveness. Applicability of the design rules for other product types is subject of further research.

Further research and actions

These practical tools will help designers to choose in favour of biobased plastics more often. The Amsterdam University of Applied Science intends to extend the research with exploring how natural filling materials can make biobased plastics more attractive and cheaper. Of course other steps have to be taken too. Material producers for example can help in providing complete and accurate data on the material properties and origin. Plastic processors can be more open for questions and testing, especially with new biobased plastics. And finally, product manufacturers can help the uptake of biobased plastics by using, for example, their marketing budgets to cover the temporarily higher prices of material and processing.

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