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Sustainable medical technology

Rethinking plastics in medical technology

Good healthcare relies heavily on medical products made from plastic. However, the widespread use of synthetic materials, particularly disposable items, creates vast amounts of waste, depletes resources and leads to a substantial carbon footprint. To create more environmentally friendly plastic products in the future, substantial changes to production processes are essential.

Plastics are ubiquitous in our daily lives. They are light, easy to mould, affordable, durable and play a crucial role in maintaining our standard of living, particularly when it comes to healthcare. Their resistance to heat, moisture and chemicals makes them ideal for sterilisation and versatile applications. Additionally, plastics are highly biocompatible and, unlike metals or natural materials, rarely trigger allergic reactions. However, these benefits come at a cost. The convenience and safety of disposable plastic products result in the generation of an enormous amount of waste, a significant consumption of resources and a substantial carbon footprint.

"Medical technology cannot function without plastics," says Dr. Julian Lotz, co-founder and Managing Director of BIOVOX GmbH in Darmstadt. "However, we need to rethink how these products are designed." Founded in 2021, BIOVOX specialises in sustainable bioplastics tailored for use in the medical field.

DEHP and PTFE need to be replaced

Plastics are used in a wide variety of forms in medical technology.
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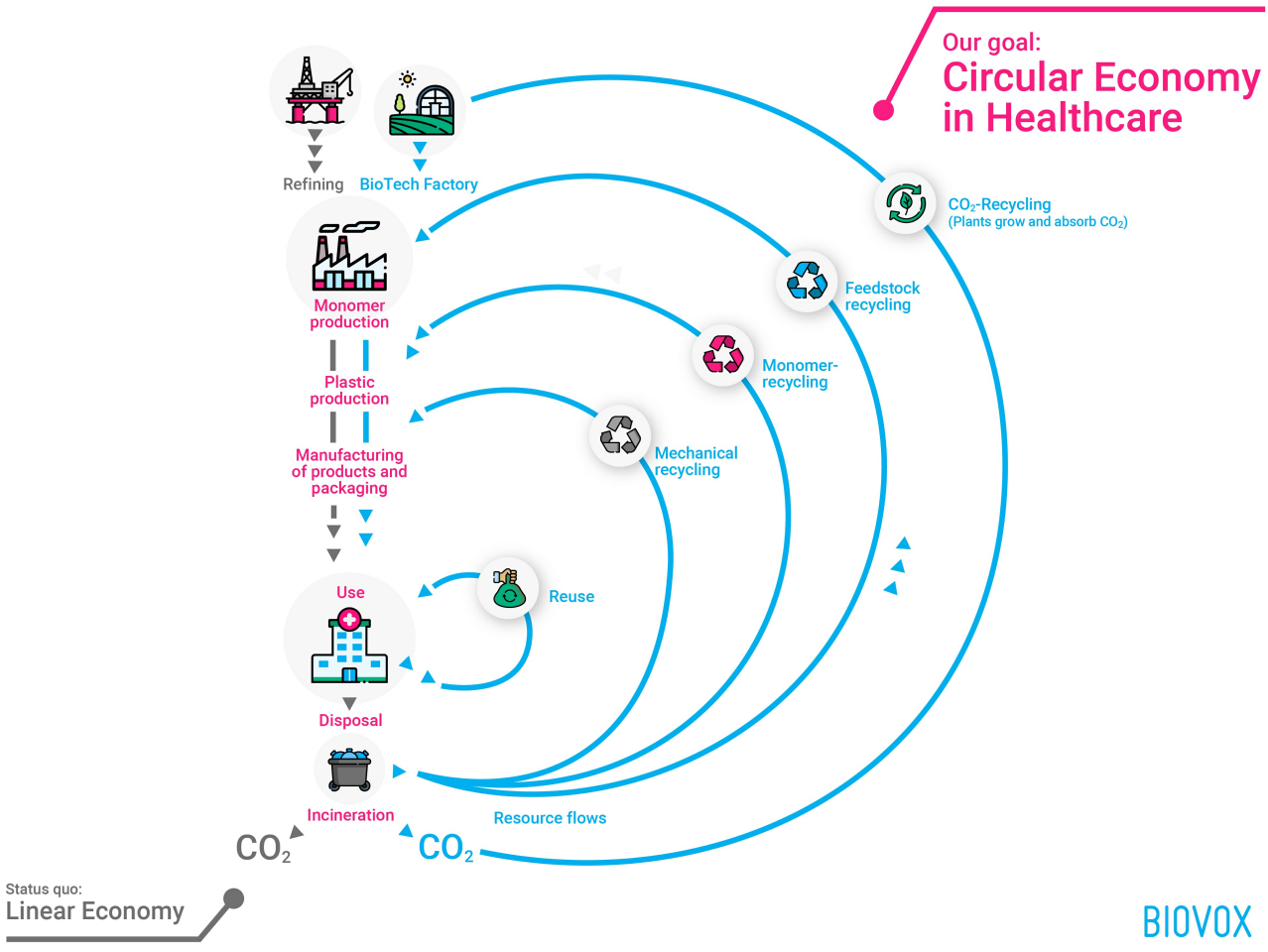
Standard polymers such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polycarbonate (PC) and polyvinyl chloride (PVC) are the most commonly used materials in medical technology. These polymers consist of long molecule chains made up of repeating monomers and are generally biologically harmless. However, it has become clear that certain additives used to enhance material properties can pose health risks. One such additive is the plasticiser, di-(2-ethylhexyl) phthalate (DEHP), which is not tightly bound to the polymer. DEHP makes PVC products flexible and is found in items such as tubes and blood bags. Prolonged exposure, especially during intensive medical treatments, can lead to toxic effects on the testes, kidneys, liver and reproductive health.[1),2)] Addressing this issue by switching to DEHP-free alternatives or using safer plasticisers such as trioctyl trimellitate (TOTM), which is non-toxic and volatile, remains a key challenge in medical technology.

Per- and polyfluoroalkyl substances (PFAS), including the high-performance plastic, polytetrafluoroethylene (PTFE), commonly used in the healthcare sector, have recently come under scrutiny. PTFE is valued for its water, grease and dirt-repellent properties, high chemical resistance, thermal stability and exceptionally low coefficient of friction. Its durability and biocompatibility make it ideal for implants, prosthetics and coatings for medical instruments such as endoscopes, where it improves gliding performance. However, it is now suspected that PFAS contribute to cancer, infertility and damage to the endocrine and immune systems. As a result, the EU is planning to ban their use.

Lotz explains: "Closely examining the specifications and critically assessing traditionally used materials is crucial. In many cases, there are now alternatives that are more environmentally friendly and compatible with human health, which may even be more cost-effective." Dr. Jürgen Stebani, CEO of Polymaterials AG, adds: "Even if no current material offers a direct replacement, it doesn't mean fluoropolymers are irreplaceable." Kaufbeuren-based Polymaterials AG specialises in developing new plastic compounds, polymers and biopolymers at the molecular level, often with the help of artificial intelligence. "For instance, we have already created fluorine-free high-performance plastics for fuel cell membranes in the automotive industry that have outperformed conventional PFAS-containing materials," Stebani says.

Stebani, a polymer chemist, points out that the raw materials industry is already phasing out PFAS production, meaning these substances will eventually become unavailable. He also notes the industry's limited interest in developing alternative materials, suggesting that this responsibility will increasingly fall on polymer manufacturers. Since material development is costly, he advises smaller companies to collaborate in researching and creating new alternatives moving forward.



In the current linear economy system (grey), petroleum-based plastic products are incinerated after use, releasing environmentally harmful carbon dioxide. The aim in the healthcare sector is to switch to biological raw materials and establish a circular economy (blue) in which products can be reused as often as possible or the materials used to make the product can be recycled. If incineration does ultimately take place, no more carbon dioxide would be released than was previously bound by the plants used to make the products.

Sustainability begins with design

Conventional plastics are derived from petroleum-based monomers, resulting in a significant carbon footprint, especially when recycling is not possible. Unfortunately, in the healthcare sector, recycling is often impractical due to regulations such as the Federation/Länder Working Group on Waste (LAGA) M18, which makes it compulsory to incinerate waste that has come into contact with blood or bodily fluids.[3)] Additionally, many medical devices are made of multiple types of plastics, which are often difficult or impossible to separate for recycling.

"We need to develop more environmentally friendly designs," urges Dr. Herwig Juster, an expert in high-performance plastics at Syensqo. "By redesigning products, we can often reduce the amount of material used without compromising functionality. Additionally, we must limit the variety of materials used and prioritise recyclable options." Juster runs a blog called FindOutAboutPlastics.com and believes that achieving the goals of the 2030 Agenda for Sustainable Development[4)] - such as quality healthcare and access to clean water – will involve the continued use of plastics. He explains that synthetic polymers offer exceptional design flexibility and require less energy to process than materials such as glass, ceramics or metal.

Another step toward greater sustainability is the implementation of take-back systems, like the ones Sanofi is introducing for its disposable insulin pens, of which it produces approximately 450 million annually. Used pens are collected and the materials used to make them separated and recycled - glass, metal, rubber and plastic - thus reducing waste and promoting resource recovery.

Bioplastics as an alternative

A shift from petroleum-based polymers to biobased plastics is crucial if we want to significantly reduce the healthcare industry's carbon footprint. Biobased plastics are derived from renewable raw materials, with natural polymers such as starch or cellulose often serving as starting materials. By incorporating co-monomers or additives, biobased materials can be engineered to possess properties similar to conventional plastics. However, when biobased products are incinerated, they do not contribute additional CO_2 to the atmosphere, as the carbon released is equivalent to that which the plants absorbed as they grew.

Biobased structural polymers currently represent only about 1% of the global plastics market[5)], partly due to higher costs driven by low production volumes. However, with innovative design, material reduction and streamlined production processes, it is entirely possible to manufacture biobased products at competitive prices.[6)] Dr. Hans von Pfuhlstein, founder of the strategy consultancy, The Strategists Network (TSN), emphasises: "Sustainability is becoming increasingly important, and the first company to bring bioplastic-based medical products to market will gain a unique selling point and a significant competitive advantage."

Medical technology is undergoing radical change

Regardless of the steps manufacturers take, every product change requires new validation and approval. Therefore, it is crucial to consider the entire product life cycle from an environmental perspective right from the development stage. Christian Pommereau, who is in charge of eco-design and circular economy at Sanofi, expresses his belief that: "Plastics will remain, but they will improve. We are in a period of transformation, and processes are becoming more complex. Achieving greater sustainability will require coordinated efforts from raw material producers, medical technology manufacturers, end users and policymakers."

In spring 2023, BIOPRO Baden-Württemberg, BIOVOX Connect and Bayern Innovativ joined forces to create the Alliance for Sustainable Medical Technology. The alliance aims to bring together key stakeholders, foster dialogue and combine resources to better prepare the industry for the future. Their events are open to all interested parties.

References:

1) DEHP als Weichmacher in Medizinprodukten aus PVC: https://www.bfarm.de/SharedDocs/Risikoinformationen/Medizinprodukte/DE/dehp_2016.html accessed 5th July 2024

2) Belastung von Olivenölen mit Weichmachern - Phthalate (DEHP, DIDP; BBP) in nativen Olivenölen (Fachinformation): https://www.lgl.bayern.de/lebensmittel/warengruppen/wc_13_fette_oele/et_weichmacher_olivenoel.htm#dehp accessed 5th July 2024

3) Vollzugshilfe zur Entsorgung von Abfällen aus Einrichtungen des Gesundheitsdienstes: https://www.rki.de/DE/Content/Infekt/Krankenhaushygiene/Kommission/Downloads/LAGA-Rili.pdf?__blob=publicationFile accessed 5th July 2024

4) 17 Zielen für nachhaltige Entwicklung: https://unric.org/de/17ziele/ accessed 5th July 2024

5) Biokunststoff-Markt - Überblick: https://biowerkstoffe.fnr.de/biokunststoffe/marktsituation aaccessed 5th July 2024

6) Nachhaltigkeit in der Medizintechnik: eine besondere Herausforderung: https://www.gesundheitsindustrie-bw.de/fachbeitrag/aktuell/nachhaltigkeit-der-medizintechnik-eine-besondere-herausforderung accessed 5th July 2024

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Dr. Ruth Menßen-Franz

Further information

Sarah Triller
BIOPRO baden-Württemberg GmbH
Email: triller(at)bio-pro.de
Phone: +49 (0)711 218 185 44

- Project website: Alliance for sustainable medical technology (only available in German)
- BIOVOX Connect
- Polymaterials AG
- Blog: FindOutAboutPlastics
- Sanofi RePen
- The Strategists Network

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