Sarah Gibbons reports on the global medical adhesives market and how it is growing in scale, diversity and innovation

Sticking together

Paradigm shifting technology involving collaboration between different scientific disciplines looks set to strengthen the impact of medical adhesives on clinical care as unhealthy lifestyles fuel increasingly diverse interventions, according to researchers and industry observers.

With sustainability "a front and centre priority," said Paul Saunders, Senior Manager, Global Marketing for Avery Dennison, a Los Angeles, US-based material science company, issues such as bone reconstruction, wound management, haemorrhage prevention and drug dispensing devices are all being enhanced, with adhesives development a key element.

Research into biocompatibility and mimicking nature, to developments in nanotechnology and wearable devices for remote healthcare monitoring, including cardiac or glucose monitors and time-release medication patches, will fuel medical adhesives global sales as new products overtake conventional wound closure measures, such as stitches and new use cases emerge, analysts predict.

The global medical adhesives market size was estimated at US$12.1bn in 2021 and is expected to hit around US$18.4bn by 2030 and expand at a compound annual growth rate (CAGR) of 4.77% between 2022 to 2030, according to a report published in September 2022 by Precedence Research, based in Ottawa, Canada.

"Technological advancements have resulted in the creation of environmentally friendly and biocompatible surgical adhesives," said the report. "Medical adhesives are now employed in a wide range of applications, from medical device assembly to internal and exterior medical uses. For example, cyanoacrylates are currently being used to treat skin wounds instead of stitches. The benefit of these products is that they may cover the whole wound. This approach prevents subsequent bleeding and thereby lowers the risk of infection."

According to the World Health Organisation (WHO), "an epidemic of unhealthy lifestyles is afflicting the worldwide population," the report notes, highlighting cardiovascular illnesses and how fibrin-based adhesives operating as a "primary binding agent with a haemostatic effect, are seeing tremendous increase in cardiac surgery." In other market research, India-based Orion Market Research said: "High demand for biomedical adhesives has progressed the development and technological advancement in the molecular mechanisms of adhesives and the development of the surface science and engineering of adhesive materials."

US-based Global Industry Analysts predicted the "promising rise of regenerative medicine is expected to further spur technology and R&D interest in next generation adhesive and sealants as smart engineered biomaterials."

Development of environmentally-friendly and "non-toxic medical-grade adhesives and sealants has opened up new avenues for growth," its report said, also covering features including substrates with nanofibres, air-purifying filter media and materials with wicking properties. "The next-generation fabrics and films include novel composites and polymer blends," said the analysts.

INSPIRED BY NATURE

Major growth is therefore projected, which could pose supply chain challenges. Indian researcher Market Data Forecast, in its January 2022 report said that while eco-friendly and biocompatible devices might deliver growth opportunities, the need for more skilled labour in manufacturing the new products "is quietly impeding the market's growth," adding, "lack of standardisation may also negatively impact the development of the market."

Researchers from McGill University in Montréal, Québec, Canada, are among those trying to deliver capacity, however. They have used nature's inspiration to create a medical adhesive they claim could save lives as it stems haemorrhaging. They first developed a hydrogel adhesive system that mimics the process slugs use to stick to substrates consisting of two parts – a hydrogel adhesive matrix and a synthetic "bridging" polyacrylamide solution. The researchers have found that flatworms and mussels contain structured porous spaces to store and secrete adhesive agents, enabling adhesion underwater. An article on this work by the UK-based Institute of Materials, Minerals and Mining said: "By incorporating these features into their original hydrogel adhesive matrix and loading

the polymer solution inside, it accelerates adhesion formation using capillary suction."

"We built xerogels, a dried format of hydrogels, with interconnected microstructures," said researcher Guangyu Bao, who now works for Massachusetts, US-based SanaHeal Inc, a healthcare bio-adhesives manufacturer.

Writing in an October (2022) ScienceDaily report, he said: "We partially impregnated those microstructures with an adhesive, functional liquid and left some microstructures dry. When our adhesives are applied to the bleeding site, the dry parts act as mini vacuums by providing capillary suction forces to rapidly absorb the blood, clearing the bleeding surface.

"When applied to the bleeding site, the new adhesive uses suction to absorb blood, clear the surface for adhesion and bond to the tissue providing a physical seal. The entire application process is quick and pressure-free, which is suitable for non-compressible haemorrhage situations." The team found that the adhesive promotes blood coagulation and it can be removed without causing re-bleeding or even left inside the body to be absorbed.

Research published on materials selection platform SpecialChem detailed other work relating to biodegradable adhesives using mussels. Eli Sone, a Professor in the department of materials science and engineering in the University of Toronto, Canada, Faculty of Applied Science & Engineering and the Institute of Biomedical Engineering and his team have been studying zebra and quagga mussels.

"If we understand why they stick so well [to marine vessels] that could help us design things like non-toxic biodegradable glues, which could offer an alternative to internal stitches for surgery or localised drug delivery applications," said Sone.

The threads they use to attach themselves to surfaces are only a few millimetres long and as thin as a human hair. But on some surfaces, a thin protein residue was left behind after detaching the creatures. The team is analysing the glues produced by mussels, with the aim of mimicking them in biomedical adhesives.

MAKING ADHESIVES STICKIER

McGill University researchers have also discovered a way to make bandages more adhesive and long lasting in wet conditions using ultrasound waves and bubbles.

Professor Jianyu Li, who led the research team of engineers, physicists, chemists and clinicians, said: "By simply playing around with ultrasonic intensity, we can control very precisely the stickiness of adhesive bandages on many tissues," he said in an August (2022) McGill university bulletin.

In collaboration with physicists Professor Outi Supponen and Claire Bourquard from the Institute of Fluid Dynamics at ETH Zurich, Switzerland, the team experimented with ultrasound induced microbubbles to make adhesives stickier. "The ultrasound induces many microbubbles, which transiently push the adhesives into the skin for stronger bio-adhesion," said Professor Supponen to the McGill report, which also quoted University of British Columbia Professor Zu-hua Gao saying: "This paradigm-shifting technology will have great implications in many branches of medicine."

Materials manufacturer Avery Dennison uses chlorhexidine gluconate (CHG) as its "antimicrobial of choice owing to its widespread use and acceptance as a skin antiseptic in hospital settings." Its BeneHold CHG antimicrobial adhesive platform combines this effective antimicrobial agent with the company's experience in skin-contact adhesives. An Avery Dennison company note said this technology, when "coupled with a transparent carrier film allows the contact layer to remain transparent and thin, making it easy to observe the site without disturbing it and offering added comfort."

A zebra mussel

WEARABLE SOLUTIONS

Germany-based coatings and adhesives manufacturer Henkel has partnered with wearable tech providers Byteflies, based in Antwerp, Belgium, to combine technology expertise of adhesives and printed electronics with remote patient monitoring solutions, meaning patches can now be worn for several days rather than one. Also, Advanced Medical Solutions, based in Israel, has been developing surgical seals designed, for example, to stop bleeding and prevent leakage of digestive tract contents into the abdominal cavity based on a polymer produced from algae, selected to reduce the risk of infection or allergic reactions.

Adhesives manufacturer Panacol, based in Connecticut, USA, last year (2022) launched a new series of minimally invasive device adhesives for use in tubing, which is fluorescent orange for high visibility in clinical settings.

Meanwhile, Dymax, light curable adhesives producers, also based in Connecticut, have brought to market a new 2000-MW series, which have been formulated without commonly used skin-irritating ingredients. In addition, the company in 2021 launched its MD 1040-M adhesive for medical devices and surgical instruments that require frequent sterilisation. A company note said the product was being sold on claims of "excellent resistance to the aggressive sterilisation methods used in medical technology and its excellent adhesion to a wide range of substrates."

Finally, New Jersey, US-based PolarSeal Tapes and Conversions has collaborated with technology providers 3M and FLEXcon, pressure-sensitive film producers from Massachusetts, to create adhesives for the wearables market.

Matthew Berdahl, Global Converter Channel Manager with 3M said: "Adhesives have the potential to unlock longer wear times, slimmer device profiles and more." For instance, 3M Medical Tape 4576 (10) is an acrylate-based adhesive intended for applications that need to be worn for up to 21 days. **PPCJ**

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