



## **Adhesive bonding technology and the circular economy – opponents or allies?**

**An absurd question, but one that illustrates the dilemma of technology  
in a European industrial society**

The EU Action Plan for a Circular Economy, which describes the transition from a linear ('throw-away') economy to a circular economy, is unfortunately often erroneously reduced to the topic of 'recycling' in popular and political discourse. 'The circular economy action plan takes a comprehensive, holistic approach to ecological sustainability assessment,' explains Professor Dr Andreas Groß, Head of the 'Training and Technology Transfer' department at Fraunhofer IFAM (Bremen), 'and does not just focus on individual elements such as recycling. The nine R strategies of the EU Commission serve as a guide for linking ecodesign and the circular economy.' In this context, adhesive bonding technology should not be reduced to the topic of 'recycling' either. Adhesive bonding technology is already an ally of the circular economy and not its opponent, with its significant contributions, which must be correctly classified in technological, social and political terms.

**Schlößer (IVK): In public and in politics, adhesive bonding technology is seen as something of an opponent of ecological developments. This is justified, among other things, by the statements that adhesive bonding is fundamentally opposed to a circular economy, that adhesively bonded products cannot be repaired, that adhesively bonded joints are not recyclable and therefore not sustainable.**

*Groß: Unfortunately, three times completely wrong! Before we begin, we should first consider the main goal of a circular economy. What a circular economy ultimately aims to achieve is to decouple necessary economic growth from the consumption of resources required for it. To do this, eco-efficiency must be optimised. And to do that, valuable materials should remain in the economic cycle for as long as possible.*



**Then recycling is the right way. The materials used in products are recycled and made available for new products. Economic growth is thus decoupled from resource consumption.**

*Unfortunately, it just doesn't work that way! This simplistic view is nothing short of negligent. It also leads in the wrong direction. Because focusing on a single topic, such as 'recycling' here, reduces the complexity of the actual goal of a circular economy in a criminally impermissible way. To put it bluntly and unequivocally: I am not speaking out against recycling. What I am just as clearly and unequivocally opposed to, however, is reducing the complex topic of the circular economy to this single aspect and making it the sole basis for assessment and decision-making. This is wrong and even counterproductive for a meaningful circular economy.*

**Can you explain it with an example?**

*Gladly! Wind energy is well suited for this: the rotor blades of wind turbines are made of glass-fibre reinforced plastics, known as GFRP, i.e. a classic lightweight material. They are purely adhesively bonded constructions, and there are good reasons for this from a joining technology point of view. Welding is out of the question. GFRP is not weldable. Selective connections of the GFRP rotor blade half-shells, such as bolted connections, riveting or nailing, are also out of the question. At the joints, they would not only destroy the GFRP lightweight material by creating 'holes', but they would also generate excessive stresses at these joints under extreme mechanical loads during utilisation. These lead to failure of the GFRP material. To compensate for these stresses and thus prevent component failure, the GFRP of the lightweight rotor blade walls would have to be heavily thickened. But that would make the whole thing so heavy that electricity from wind energy would no longer be an option. What I want to say is this: If we focus on the fact that GFRP is not recyclable as a material and on the joints that are made using adhesive bonding that supposedly prevent recycling, the logical consequence would be to ban GFRP and adhesive bonding technology in rotor blades. I don't need to answer the question of whether we would still have wind energy as a renewable energy generation technology tomorrow...*



## **How should adhesively bonding be considered in a circular economy?**

*It is always the case that issues must be considered and evaluated holistically. This also applies to the joining technology 'adhesive bonding'. The EU Waste Framework Directive is of central importance for its relevance to the life cycle assessment in the context of a circular economy. It is not recycling that is at the top of the list, but waste avoidance. This is followed by waste recovery, i.e. preparation for reuse, only then recycling and then other forms of reuse, such as organic reuse. At the end of the list is waste disposal. For this – and I emphasise this expressly – very well thought-out framework directive, the R-strategies form the holistic core concept. If, as actually intended, all R-strategy elements are used together, for example for the ecological-sustainable assessment of rotor blades for wind turbines, one thing quickly becomes clear: the ecological advantages in utilisation are likely to outweigh the ecological disadvantages at the end of the rotor blade's life.*

## **Since it seems that the 'R strategies' are not yet sufficiently well known, what is the background to them?**

*Yes, the low level of awareness is not just a pity. It is equally a problem. On the one hand, the R-strategies are a suitable approach for future ecological technology assessment, and on the other hand, they represent a guideline for rethinking the use of technology in products in a new and future-oriented way. What I want to say is that with the R-strategy elements, we have a serious and at the same time very future-oriented approach. This is already clear when we look at the order of priority of the nine individual elements of the R-strategy as defined by the Commission: R1-Refuse, R2-Rethink, R3-Reduce, R4-Reuse, R5-Repair, R6-Refurbish, R7-Remanufacture, R8-Repurpose and R9-Recycle. In other words, the transformation towards a circular economy is not just about a single element. It also doesn't just consist of 'R9 - Recycling'. Instead, it definitely encompasses much more. And don't forget: 'R9-Recycling' is only mentioned last. The EU Commission deliberately placed the other R-strategy elements R1 - R8 and their ecologically sustainable significance before recycling.*



## **What do the R-strategy elements mean in the context of adhesive bonding and what impetus do they provide?**

*Let's start with R1 – Refuse, i.e. refusing a product. This is a non-technology-specific, superordinate R-strategy element that leads to the question: Do we need the product at all? In the mindset of an 'affluent society', this is where a paradigm shift quickly begins.*

*R2 – Rethink has several aspects and leads, for example, to more intensive use of a product, e.g. due to its longer shelf life. R2 – Rethink is relevant to adhesives. The verifiably long-term stability of adhesively bonded joints extends the utilisation phase of the life cycle for the highly and necessarily adhesively bonded products listed below. The average lifespan of a car is constantly increasing. The total mileage of an ICE train with a projected lifespan of 40 years and an annual mileage of 500,000 km is 20 million km. Aircraft fly for up to 30 years and are regularly monitored and repaired for this purpose. Wind turbines are designed for 25 years. Improving product longevity to conserve raw materials within the circular economy is one of the most effective resource-efficient ecodesign strategies in terms of strategy element R2 – Rethink. Adhesive bonding technology significantly supports R2.*

## **How do adhesive bonding and R3 – Reduce fit together in terms of the circular economy?**

*These go very well together! Take lightweight construction, for example. Lightweight construction means the same functionality with reduced use of materials, i.e. R3 – Reduce. Lightweight design is one of the most effective ecodesign strategies for conserving resources, saving energy in product use and avoiding waste. So why is R3 – Reduce relevant to adhesive bonding? Adhesive bonding technology is one of the most important joining technologies for implementing both constructive and material lightweight construction. Its unique selling point in the context of all joining technologies, namely joining all materials with themselves and others in a long-term stable and secure manner while at the same time maintaining material properties – in this case lightweight construction properties – in the product, comes into its own. Consequently, adhesive bonding technology supports R3 –*



*Reduce as a key to a circular economy.*

*R3 – Reduce is also part of the miniaturisation trend. In electronics manufacturing, functionalities are constantly increasing and require ever smaller dimensions. Why is adhesive bonding technology relevant to R3 – Reduce in the context of miniaturisation? Conventional joining technologies can no longer realise the ever smaller dimensions. This is why adhesive bonding technology is essential here, along with the specially developed adhesives that meet these requirements. They join completely different materials in miniature components in a material-preserving manner, are fast, secure, long-term stable and highly precise – even in large-scale production – in the smallest of spaces. They fix coils. They are used for sealing housings. They protect fine chip structures and wires in the high-reliability area as chip encapsulation compounds against mechanical stresses such as vibrations, against thermal stresses caused by temperature fluctuations, against environmental influences such as humidity and even against corrosion. This can only be achieved with significantly more effort or not at all using other joining techniques. These examples also involve a great deal of R2 – Rethink, which is only made possible by adhesive bonding. This also shows that the strategy elements should be used in a networked way.*

## **What about the circular economy in terms of the strategy elements R4-Reuse, R5-Repair, R6-Refurbish, R7-Remanufacture and R8-Repurpose?**

*Among these R-strategy elements, I will focus on R5 – Repair. Repairing an item extends its useful life. Raw materials are kept in the economic circle for longer, as intended. Adhesive bonding is probably the most frequently used repair method, even for non-adhesively bonded products. For example, for decades, defective window panes in means of transport have been removed and new panes are adhesively bonded in accordance with specified, proven procedures. The removal and installation of the panes is already taken into account in the design. This is the state of the art. This example can be applied to almost all other areas of adhesive bonding technology, such as shipbuilding, optics, (dental) medicine, medical technology, household appliances, mobile phones (display windows), the acoustics industry, the shoe and sports equipment industry, and many more.*



**It is widely believed that adhesively bonded products are not recyclable or are so only with difficulty. How do you evaluate adhesive bonding technology in this respect?**

*Even with the most ecologically innovative product design and optimised product manufacturing and use, products become waste after the longest possible product life cycle phase of 'utilisation'. Why? The effort for R4 - R8 becomes too high due to the additional consumption of materials and energy and is then economically and – even more – ecologically nonsensical.*

*And when it comes to recyclability, we have to clearly distinguish between facts and perception or, in the worst case, 'fake news'. First, the facts: All joints can be detached, even adhesively bonded joints! It is therefore not the joining technology that determines recyclability. It is the materials! This means that, consequently, adhesive bonding technology is not the factor that determines recyclability.*

*The fact that the correct technical and technological classification of adhesive bonding technology as a 'non-detachable joining technology' is unfortunately commonly and politically misunderstood is an issue that the adhesive bonding technology industry urgently needs to address in its communications. But this misunderstanding shows that a technology, and that includes adhesive bonding, is not immune to being talked down due to 'half-knowledge' or other intentions, which I'd rather not go into now. The much-vaunted 'openness to technology' – one basis for R2–Rethink – ultimately also leads to the question of where 'openness to technology' leads when technologies are no longer evaluated on the basis of facts and meaningful rules. The example of wanting to replace the proven, risk-based regulatory approach with a hazard-based approach as part of the European chemicals strategy is just one example in this context. (Link to 'guinea pig' interview no. 1).*

**So adhesive bonding technology is not an opponent of a circular economy, but an ally?**



*Definitely an 'ally'! In the context of a circular economy, adhesive bonding technology must be seen as a key technology. Any other view would be nonsense. To optimise eco-efficiency, materials are joined using adhesive bonding technology to create long-term stable and secure joints that can be separated again for repair or material recycling. Contrary to the false public, political and official assessment, adhesive bonding is an ecologically sustainable technology, both overall and in the context of falsely overrated recycling. Adhesive bonding technology is not a problem for the circular economy. Rather, adhesive bonding technology is part of the solution for a circular economy!*

## **What needs to happen now?**

*I see a need for action at various levels here.*

*In the context of R-strategies, manufacturing companies must evaluate adhesive bonding technology more holistically in many areas and, if necessary, rethink it. The potential and benefits for future-proof and successful products will be high – so it's worth it.*

*Politics must return to holistic thinking, holistic evaluation, holistic classification and holistic action. The example of wind turbines alone shows that, when viewed comprehensively – keyword 'R-strategies' – the ecological benefits during utilisation far outweigh the disadvantage of the inability to recycle materials at the 'end of life'. This can also be applied to many other areas of application for adhesive bonding technology. The prevailing focus on details and the resulting detailed decisions that are used as the basis for overall decisions must therefore be stopped immediately and once and for all. Recycling is just one example here. A meaningful technology assessment and political dogmatism are simply not compatible. They are mutually exclusive!*

*In view of the growing variety of materials required, adhesive bonding technology is a key technology of the 21st century – in technological, ecological and economic terms. It is time that this message was received by industry and politics, as well as by authorities and end*



*users. The world's leading German adhesive manufacturing and adhesive processing industry is particularly in demand here. And if everyone acts more and talks less, adhesive bonding technology will open doors for us in many ways as a technological, ecological und economical ally – including doors that we cannot even see today. After all, the '21st century' still has many years ahead of it.*

**Thank you for the interview, Professor Dr Groß.**

Further information: [www.klebstoffe.com](http://www.klebstoffe.com), [www.klebstoffe.com/presse](http://www.klebstoffe.com/presse)

**About the German Adhesive Association (Industrieverband Klebstoffe e. V. - IVK):**

The German Adhesives Association (Industrieverband Klebstoffe – IVK) represents the economic and technical interests of the German adhesives industry in relation to the public, authorities, consumers and scientific institutions. The IVK has more than 155 member companies, including manufacturers of adhesives, adhesive tapes, sealants and adhesive raw materials, as well as scientific institutes and system partners. The German adhesives industry employs around 18,000 people.

**Picture\_01: IFAM 9R statt nur R9 R-Strategien\_NEW\_EN**

Foto: © Fraunhofer IFAM

**Picture\_02: Prof. Dr. Andreas Groß**

Foto: © Fraunhofer IFAM



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