Circular Economy and Adhesive Bonding Technology, Part 1

Do the circular economy, life cycle assessments and adhesive bonding technology fit together? The first part of the articles series based on a study by Fraunhofer Institute for Manufacturing Technologies and Advanced Materials IFAM sheds light on the EU circular economy action plan to fulfil the "Green Deal" and explains the associated fundamental impacts on joining technologies.

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The "European Green Deal" (*Figure 1*) is an overall concept presented by the European Commission. It aims to make Europe the first climate-neutral continent by 2050 by reducing net greenhouse gas emissions in the European Union to zero by 2050 and making the "Green Deal" a central part of the European Union's climate policy. The plan will be based on social, economic and environmental impact assessments and will ensure a level playing field and promote innovation, competitiveness and employment [1].

The circular economy strategy represents a part of the Green Deal. In its fundamental considerations, the circular economy is based on the simple fact that in a materially finite world, as represented by the closed system "Earth", the production processes of a "linear economy" (*Figure 2* left) are not sustainable without a true material circularity. In the foreseeable future, the fossil, i.e. non-renewable resources used so far will be exhausted as sources. This will be accompanied by the exhaustion of the areas available for the landfilling of waste and residues from industrial production.

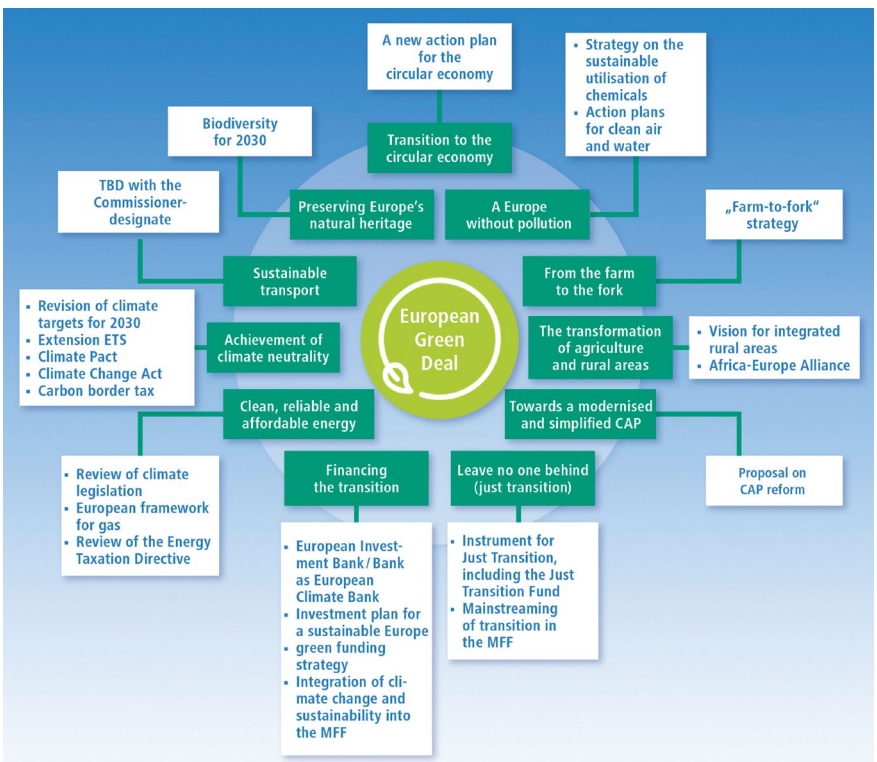

Figure 1 > Classification of the EU circular economy action plan to fulfil the "Green Deal" [2]

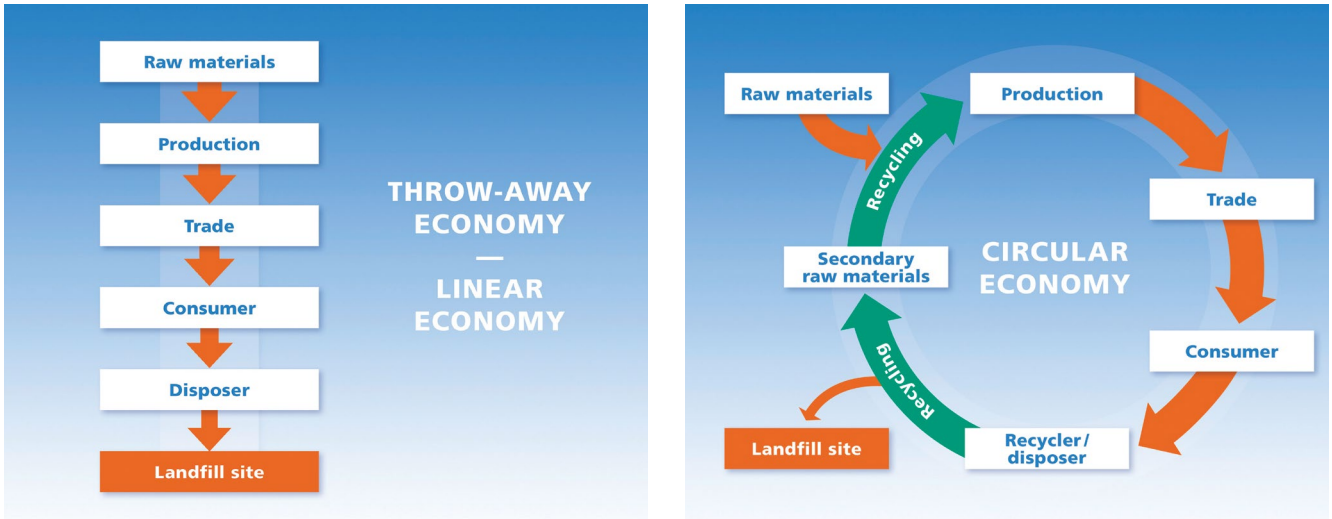

Figure 2 > Schemes of the linear economy ("throw-away economy") and circular economy

Consequently, the cycle of the respective product life cycles from production and consumption to waste disposal and the market for secondary raw materials is to be closed. The action plan focuses primarily on the areas of

- electronics and information/ communication technology,
- batteries and vehicles,
- packaging,
- plastics,
- textiles,
- construction and buildings,
- food, water and nutrients

with the aim of accelerating the transition to a circular economy along their value chain [3].

The circular economy (*Figure 2* right), in contrast to the linear economy (*Figure 2* left), therefore represents a regenerative, renewable system. In this system, the use of resources, the production of waste and emissions, and the waste of energy are minimised. This is achieved by slowing down, reducing and closing energy and material cycles. Tools for implementation include long-lasting constructions, maintenance, refurbishment, repair (capability), reuse, remanufacturing and recycling [4].

Changing product requirements

- **The role of materials and joining technologies**

Materials are an important factor in meeting future product requirement profiles. New types of requirement profiles are a driving force in materials science. The new requirements arise from the major future fields such as energy, climate and environmental protection, resource conservation, mobility, health, safety or communication. In order to be able to meet these requirements, materials science combines an interdisciplinary approach that is more knowledge-oriented in the field of materials science with an approach that is more application-oriented in the field of materials engineering. Both together constantly lead to research results, without which continuous progress, for example in the fields of mechanical engineering, transport construction, the aviation industry, the chemical industry, medical technology, energy technology or environmental protection would be inconceivable. It is therefore not without reason that current studies show the direct or indirect dependence of a large number of technical innovations on the respective material. The consequence of material developments is that the variety of special materials for the manufacture of products is increasing in order to meet the changing demands on products in this way (*Figure 3*).

However, materials only become usable and they also only develop their innovative power when not only do their properties fundamentally contribute to the fulfilment of the requirement profile, but the materials in the product, in the component or in the component part can also be joined with themselves or other materials in real terms. Consequently, systems composed of different materials, so-called multi-component materials, will undoubtedly be necessary in the future. And

About the Study

The study "Circular Economy and Adhesive Bonding Technology" by Fraunhofer IFAM describes the role of adhesive bonding technology in the context of the circular economy in a cross-industry and comprehensive manner and places it in the political framework from a global and European perspective. This includes life cycle assessment-relevant aspects generated in adhesively bonded products that go beyond the effectiveness of the circular economy. At the same time, the study presents the technological and ecological performance of adhesive bonding technology both as a partner for meeting the requirements of a circular economy and as the leading joining technology of the 21st century.

The entire study is available as a free download in German and English:
https://go.sn.pub/IFAMstudyGerman
https://go.sn.pub/IFAMstudyEnglish

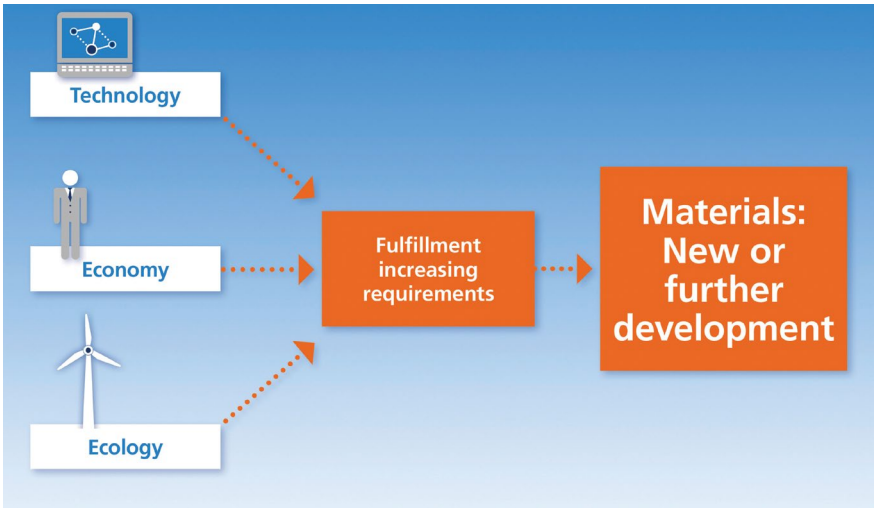

Figure 3 > Fulfilment of changing requirements by materials

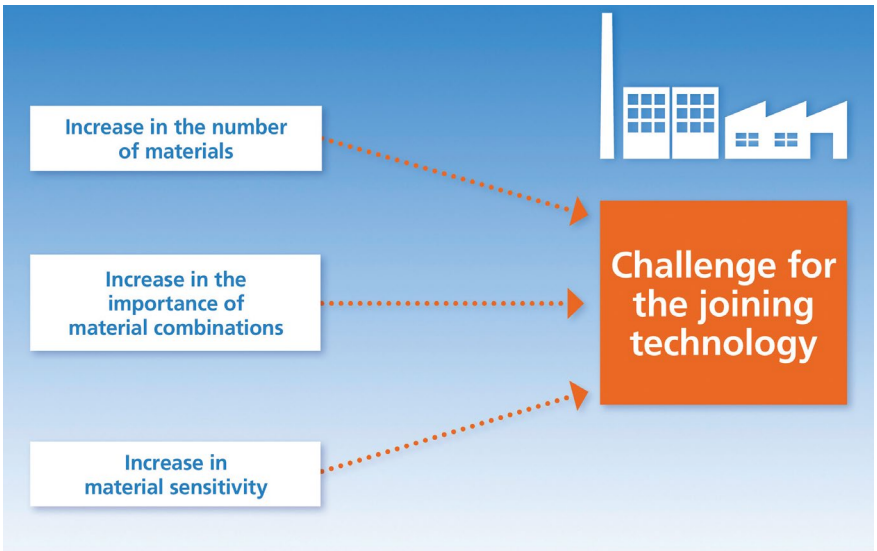

Figure 4 > Consequence of material developments: The challenge for the joining Technology

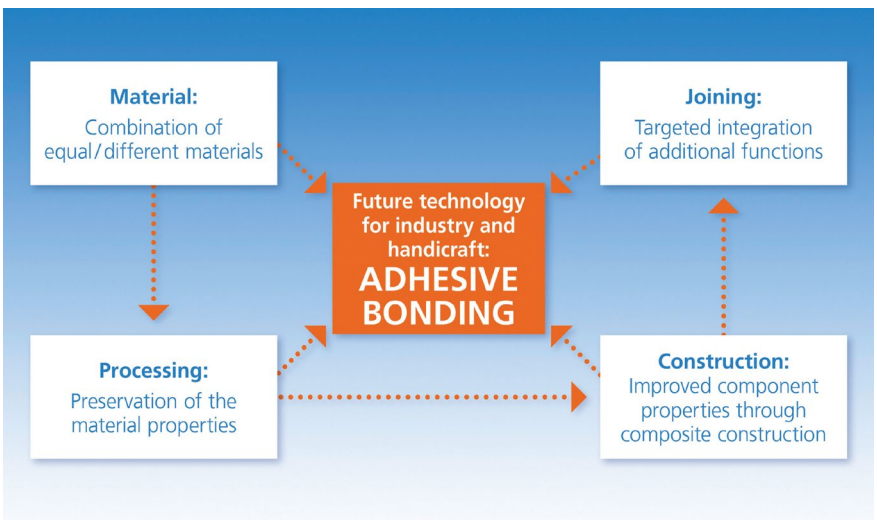

Figure 5 > Reasons for the key position of adhesive bonding technology

it is precisely from this that the challenge for joining technology arises (*Figure 4*).

• The role of adhesive bonding technology

The preservation of the respective material property for the fulfilment of product requirement profiles is often not given with traditional joining technologies when joining with itself and/or other materials. Adhesive bonding technology, on the other hand, fulfils precisely this property and therefore occupies a key position in this context of joining technologies (*Figure 5*). With adhesive bonding technology, all materials can be joined together with long-term stability while retaining the material properties. The preservation of material properties during adhesive bonding thus opens up new construction methods that are not possible with other joining techniques. Compared to welding or soldering, the adhesive bonding process, even with hot-curing adhesives, is relatively low in heat and therefore preserves material properties. There is also no damage to the parts to be joined due to perforation, as is the case with riveting or screwing. In addition, the stress distribution of an adhesively bonded joint is almost uniform under load, whereby adhesive bonding fulfils the main functions of "force transmission" and "deformation compensation". Furthermore, functions that go beyond these main functions, which may be relevant for the circular economy, can additionally be integrated into the adhesively bonded joint.

Therefore, due to this unique ability of adhesive bonding technology, there is hard-

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Figure 6 > Adhesive bonding – hardly an area where it is not used

ly any industrial, handicraft or household-related area today in which the joining technology "adhesive bonding" is not used. Adhesive bonding already surrounds us in most areas of our lives (*Figure 6*), has long been an integral part of innovative technology development and leads to an indirectly generated value added of approx. 450 billion € annually in Germany alone (as of 2018). //

References

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[2] European Compost Network ECN (2020), https://www.compostnetwork.info/eu-green-deal (access: April 30, 2020)

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[4] M. Geissdoerfer, P. Savaget, N.M.P. Bocken, E.J. Hultink: The Circular Economy – A new sustainability paradigm? Journal of Cleaner Production 143 (2017) 757–768

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