Understanding the bonding strength of hybrid-produced thermoplastic composites to enable homogenous recycling

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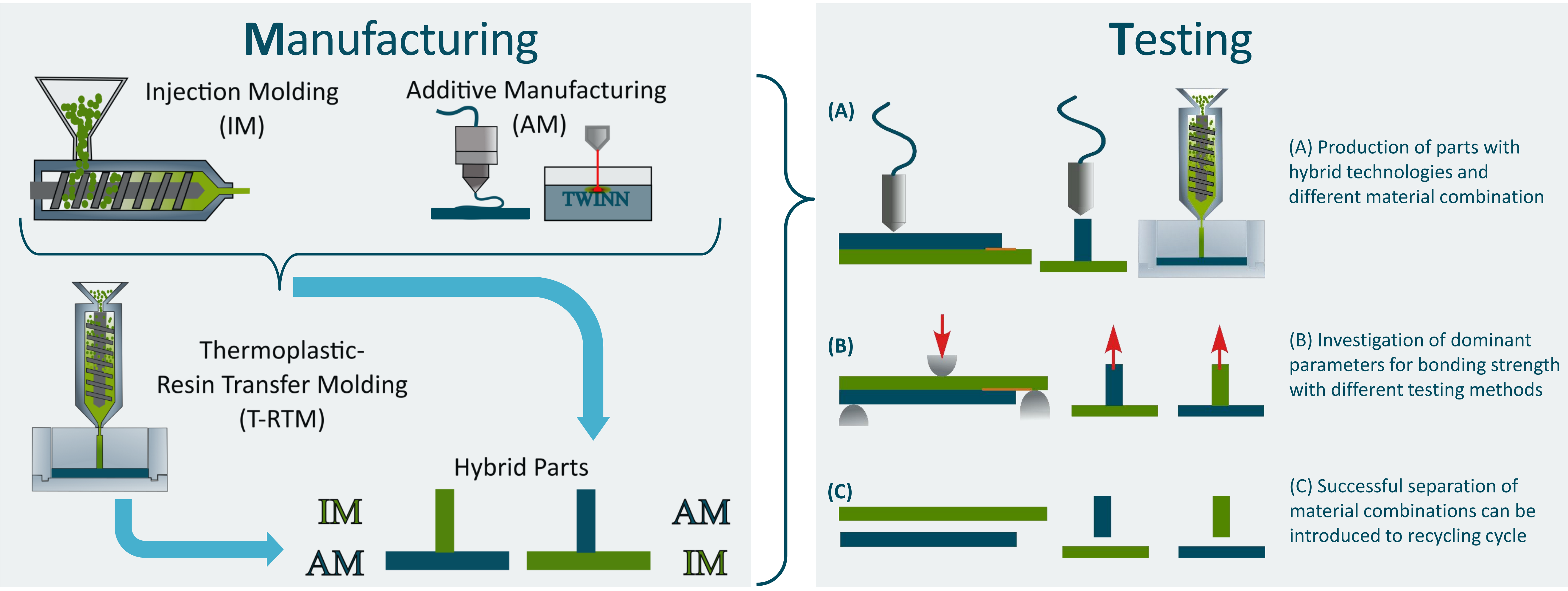
INTRODUCTION

Nowadays the development of technologies leads to more possibilities regarding applications and properties. Especially the progress of existing technologies enables the production of high-performance composite structures with recyclable thermoplastic matrices. By combining different processing technologies, a hybrid-produced part joins their advantages. Nevertheless, by combining materials and technologies the path at end of life usually ends in thermal recycling. Without doubt this is a waste of resources, since thermoplastic components can be easily recycled if separated correctly.

METHODOLOGY

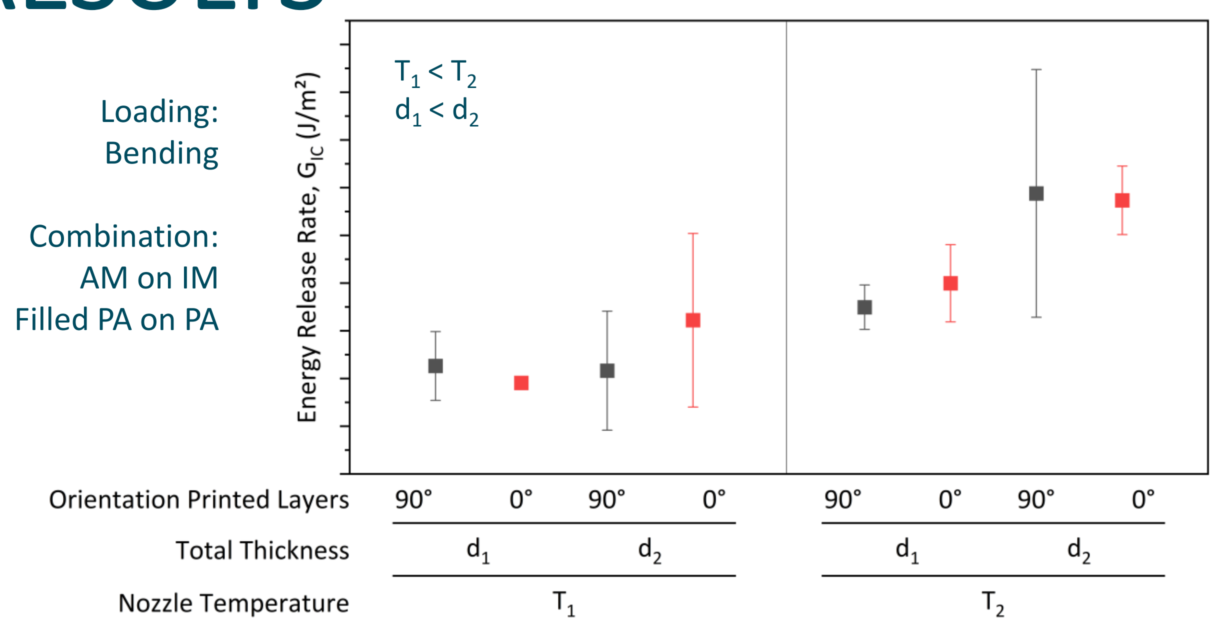
Within the IPPT_TWINN project it is the goal to manufacture thermoplastic composites via hybrid technologies as thermoplastic resin transfer molding (T-RTM) [1], injection molding (IM), and additive manufacturing (AM). Not only technologies are combined, but also materials such as polyamide and thermoplastic elastomers, to adapt properties locally, e.g., the bonding strength. Especially AM enables the individualization of parts. Therefore, AM will be applied to print structures or geometries on test specimens manufactured via the T-RTM and IM technology .

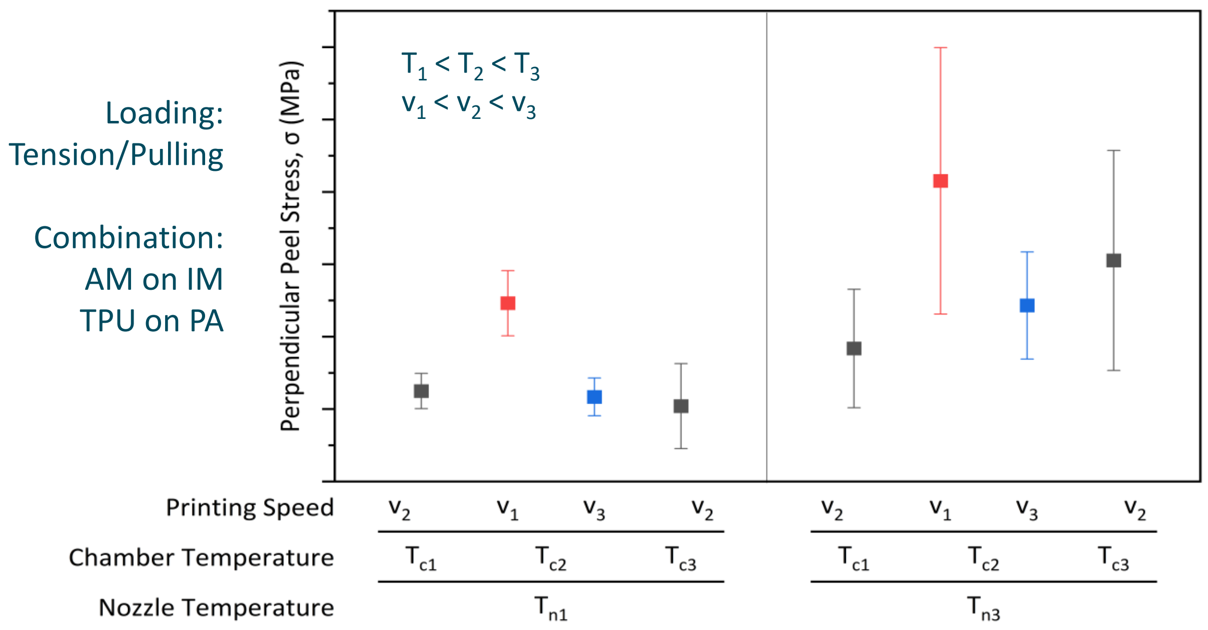
To study the correlations between printing parameters and bonding strength, a mathematical model is developed [2]. Finally, the bonding strength is tested by fracture mechanical approaches. These tests provide information of the maximum bonding strength and, hence, the required energy to separate the materials from each other. By this, the separated materials can be recycled in a homogenous material stream to raw material and, thus, reused.



RESULTS

$$\boldsymbol{M}(process, material, combination) + \boldsymbol{T}(A(v, T, p, \dots), B(v, t, F, T, \dots), C) = Q\ (hybrid\ part)$$





CONCLUSION

The correlation between bonding strength and the single parameters, follows a polynomial function, with an optimum in bonding strength for a special parameter setting. This correlation defines the hybrid part quality. By combining different settings optimums at a similar level can be achieved. Further tests are planned to include more processing parameters.

Considering this information, composite parts can be optimized in the bonding but furthermore separated to ensure a homogenous recycling stream which is necessary to keep the quality of recycled material. Thermoplastic materials can therefore be combined in composites but also fully recycled.

REFERENCES

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