INJECTION OF POLYMERIC SANDWICH STRUCTURES

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SUMMARY: This research examined the use of polymeric sandwich structures with bimaterials in the production of toys. The advantages and disadvantages of using bimaterials were analyzed, as well as examples of bimaterials used in sandwich polymeric structures. The results suggest that using bimaterials in sandwich polymeric structures can improve the properties of toys by combining the different properties of the materials and improving the quality and durability of the final products.

KEYWORDS: Injection, sandwich, polymeric, bimaterial, toys.

1. Introduction

The production of toys has evolved significantly in recent years, especially due to the development of technology and new materials. The use of polymeric sandwich structures in the production of toys is an innovative method of improving the quality and durability of the final products. These structures are composed of two thin material sheets with an insulating core in between, thus providing superior mechanical properties compared to ordinary materials. In addition, the use of bimaterials in sandwich polymeric structures can offer additional advantages by combining the different properties of materials.

The purpose of this research is to examine the use of polymeric sandwich structures with bimaterials in the production of toys. The advantages and disadvantages of using bimaterials will be analyzed, as well as examples of bimaterials used in sandwich polymeric structures. Finally, it will be highlighted how the use of these structures can improve the quality and durability of toys by combining the different properties of materials.

The research was conducted by studying specialized literature, scientific publications, and technical reports on the use of polymeric sandwich structures with bimaterials in the production of toys. Practical examples of using these structures in toy production were also analyzed. The obtained information was synthesized and analyzed, and the results of the research are presented in this document.

2. Current status

The current state of research regarding the injection of bimaterial polymer sandwich structures in toy production is in continuous development and exploration. This field benefits from increased interest as ways to improve the quality and durability of toys are sought.

An important aspect of current research is the identification and development of new materials suitable for bimaterial polymer sandwich structures. A wide range of materials are being analyzed, including polyurethane foams, expanded polystyrene, polycarbonate, nylon, and others. Materials that offer superior mechanical properties, impact resistance, wear resistance, and low weight are sought.

Regarding the injection process, research is focused on optimizing injection parameters to achieve high-quality polymer sandwich structures. Aspects such as injection temperature, injection pressure, cooling time, and others are considered to ensure even material distribution and to avoid defects in finished products.

Another important aspect of current research is the evaluation of mechanical properties and durability of toys produced with bimaterial polymer sandwich structures. Bending tests, impact tests, tensile strength tests, and other tests are performed to evaluate the performance of finished products. Safety and toxicity aspects of the materials used in production are also evaluated.

In addition to theoretical and experimental research, advanced simulation and analysis models are being developed to better understand material behavior and optimize manufacturing processes.

3. Bimaterials in polymeric sandwich structures

3.1 Definition and characteristics of bimaterials:

Bimaterials are materials composed of two or more different materials that are bonded together in an integrated structure. These materials are designed to combine the properties and advantages of each material, while minimizing their disadvantages. Thus, bimaterials offer a number of advantages compared to single materials.

3.2 Advantages and disadvantages of using bimaterials

The main advantages of using bimaterials in sandwich polymer structures include:

• Combination of the mechanical and physical properties of the two materials, such as stiffness and impact resistance

• Cost and weight reduction by using a cheaper and lighter material in combination with a more expensive and heavier one

• Increased durability by using a wear and corrosion-resistant material in combination with a material that is resistant to tension and bending

As for the disadvantages, the use of bimaterials can be more challenging in terms of design and manufacturing processes. There may also be difficulty in selecting the appropriate materials to achieve the desired properties and good adhesion between them.

3.3 Examples of bimaterials used in sandwich polymer structures [1]

There are a variety of bimaterials that can be used in toy production to achieve specific properties and improved performance. Here are some examples of bimaterials used in toy production:

1. ABS (Acrylonitrile Butadiene Styrene) + TPU (Thermoplastic Polyurethane): This combination of materials provides superior mechanical strength and durability. ABS provides impact resistance and rigidity, while TPU provides flexibility and elasticity. This bimaterial is often used in toys that require shock resistance and flexibility, such as action figures or components of interactive toys.
2. PP (Polypropylene) + EVA (Ethylene Vinyl Acetate): This combination offers a unique combination of strength, lightness, and cushioning ability. PP provides strength and

rigidity, while EVA provides shock absorption and flexibility. This bimaterial is often used in baby toys, such as teething toys or soft toys.

3. PVC (Polyvinyl Chloride) + PU (Polyurethane): This combination of materials provides strength, durability, and flexibility. PVC provides strength and rigidity, while PU adds flexibility and elasticity. This bimaterial is often used in the production of inflatable toys, such as air mattresses or beach balls.

These are just a few examples of bimaterials used in toy production. Custom combinations of materials can be made to achieve the desired properties and performance based on the specific needs and requirements of the toy.

4. The injection process of sandwich polymer structures with bimaterial in toy production

4.1 E The process of injection of sandwich polymeric structures with bimaterial in the production of toys involves the following stages in the injection process [2]:

1) Mold preparation: The mold is prepared in advance to form the sandwich polymeric structures. This includes cleaning and preparing surfaces, mounting mold components, and ensuring a polymer material feeding system.
2) Heating the polymer material: Polymer materials, whether granules or powders, are heated in a cylinder of the injection machine until they melt and become liquid. Typically, two cylinders are used for the two bimaterials used in sandwich structures.
3) Injection of the first material: The first polymer material is injected into the mold cavity to form the outer layer of the sandwich structure. Injection pressure and speed are controlled to achieve uniform and complete cavity filling.
4) Completion with the second material: After injection of the first material, injection of the second polymer material begins immediately. It is injected simultaneously or in a subsequent stage, filling the remaining space in the mold cavity to form the core or inner layer of the sandwich structure.
5) Cooling and solidification: After both materials have been injected, the mold remains closed for a period of time for the structure to cool and solidify. This allows the material to maintain its shape and stability.
6) Separation and finishing: After solidification, the sandwich structure is separated from the mold. Any excess material or burrs are removed through cutting, grinding, or milling processes. Then, the finished product can be subjected to additional finishing operations, such as polishing or applying colors and decorations.

4.2 Equipment used in the injection of bimaterial polymer sandwich structures [3]:

a. Injection molding machine: This is the main equipment in the injection process. The injection molding machine is responsible for heating and melting the polymer materials, as well as injecting them into the mold cavity. It consists of a material feeding system, a heated cylinder, and an injection system such as a screw or a piston, which controls the injection speed and pressure.

b. Mold: This is a tool used to shape and determine the final geometry of the polymer sandwich structures. The mold is made of steel and consists of two or more parts that can be opened and closed to allow the polymer material to be injected. It includes the main cavity, where the sandwich structure is formed, as well as the feeding channels and cooling system.

c. Temperature control system: This is essential to maintain the proper temperature of the mold and polymer materials during the injection process. It includes heating and cooling units such as resistors or water pipes, which ensure that temperatures are precisely controlled according to the requirements of the materials used.

d. Auxiliary equipment: Depending on the specific requirements of the injection process, other auxiliary equipment may be necessary, such as material dosing and mixing systems, material pre-treatment equipment (such as granule dryers or release agents), excess material recovery systems, or process control and monitoring equipment.

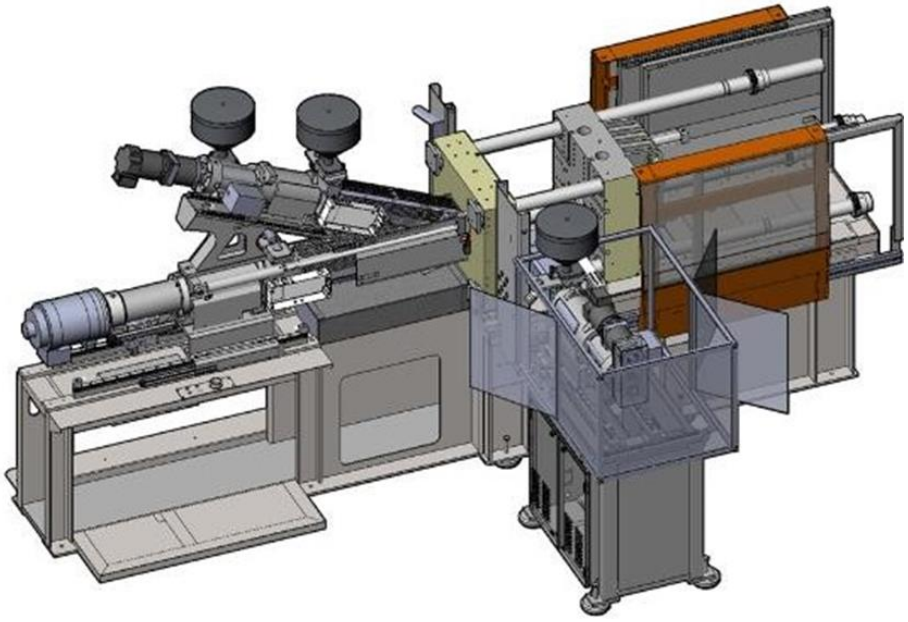

Fig.4.1. Polymer sandwich structures injection machine

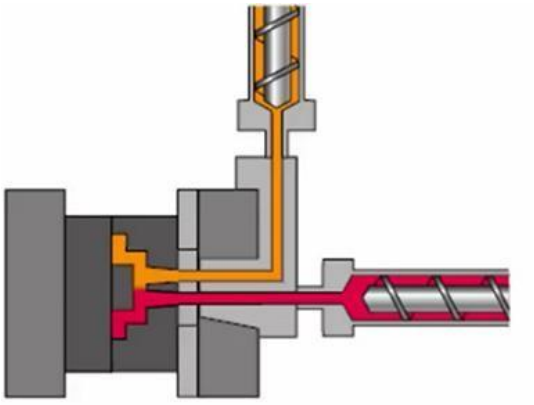

Fig.4.2. Polymer sandwich structures injection representation

5. Applications in toy production

Advantages of using bimaterial polymer sandwich structures in toy production [4]:

The use of bimaterial polymer sandwich structures in toy production brings numerous advantages, including:

• Lightweight: Polymer sandwich structures are characterized by their lightweight, making them ideal for toys. They provide children with a comfortable and easy playing experience, allowing them to handle and play with toys without difficulty.

• Impact resistance: Polymer sandwich structures are known for their impact resistance. This aspect is essential in toy production as toys are frequently subjected to falls and shocks during use. The use of polymer sandwich structures ensures better protection of toys and reduces the risk of damage or tearing due to impact.

• Durability: Toys produced with bimaterial polymer sandwich structures are durable and resistant to wear. They can withstand time and maintain their appearance and functionality for a longer period. Toy durability is essential to ensure long-term satisfaction for children and to reduce the need for frequent toy replacement.

• Versatile design: Polymer sandwich structures allow for great flexibility in toy design. They can be manufactured in different shapes, sizes, and colors, allowing manufacturers to create attractive and innovative toys that appeal to children. Additionally, complex details and textures can be created to provide a pleasant visual and tactile experience.

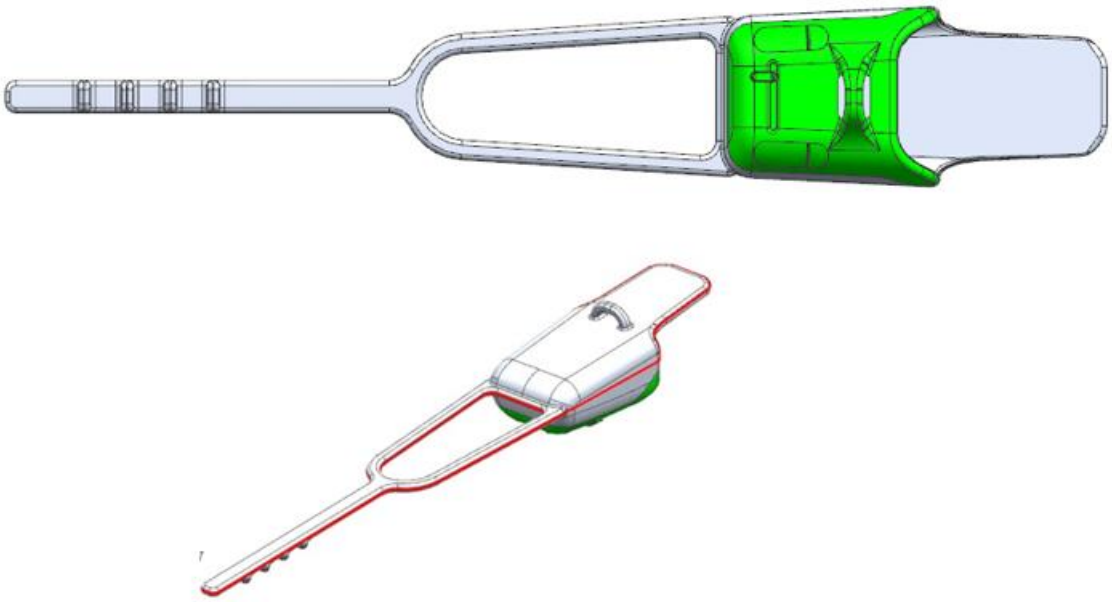

Fig.5.1. Example of a toy made by bimaterial injection

6. Conclusions

Based on the research regarding the injection of bimaterial polymer sandwich structures in toy production, it can be concluded that this technology has great potential and a series of advantages for toy production. The use of these structures can provide toys with superior mechanical properties, such as impact resistance and stiffness, while maintaining low weight and high design flexibility.

The injection process of bimaterial polymer sandwich structures is a complex process that requires specialized equipment and technologies, but high-quality products can be obtained by using modern equipment and superior materials. However, to further improve this process and contribute to greater sustainability in toy production, future research can focus on the use of ecological and renewable materials, as well as the development of more efficient and energy-saving technologies. Additionally, further efforts are needed to ensure the safety of toys produced with bimaterial polymer sandwich structures, by adhering to appropriate safety standards and regulations.

Overall, research on the injection of bimaterial polymer sandwich structures in toy production has shown that this technology has enormous potential and can contribute to the development of more durable, safer, and more attractive toys for children.

7. Bibligraphy

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