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Two-component injection molding: present and future perspectives

Aminul Islam and Hans Nørgaard Hansen

A technology that promises cost-effective and convergent manufacturing approaches for both macro and micro applications still has a way to go.

Injection-molding techniques that combine two different plastic materials—and in particular their associated properties—in the same product are known as two-component (2C) molding. The screwdriver handle, toothbrush, and computer mouse are all familiar examples of 2C products. These molding techniques are used to combine hard and soft plastic materials, to make movable flexible joints, as well as to increase the aesthetic value of a product. More advanced applications of the technology include molded interconnect devices (MIDs), acoustic absorbers, and parts for sealing. 2C molding has also recently attracted interest as a promising solution to ejection problems and for making high-aspect-ratio (i.e., of length to diameter greater than 10:1) microstructures.

Two of the most important technical considerations in 2C molding are polymer-polymer bond strength and the interface between polymers. In most applications, good bonding is critical to the mechanical performance of the final product and also to prevent plastic parts from breaking during ejection after molding. Likewise, uses such as selective metallization of polymers and micro-2C molding, as well as aesthetics, depend on a sharp and well-defined interface between materials.

Our own experimental investigations show that polymer-polymer bond strength is affected by injection-molding process parameters, surface roughness of parts, and material solubility, and also by environmental factors such as humidity, corrosion, and thermal cycle. Conditions that favor the melting and mixing of plastics during 2C molding increase the possibility of good bonding. But some materials—for example, liquid crystal polymer and polyoxymethelene—have poor natural adhesion. Consequently, we are often left with a tradeoff between polymer-polymer bond strength and interface quality. Parameters and conditions that increase bonding negatively affect the interface of the 2C molded part. We have also observed that high affinity of two polymers hinders the selectivity of any subsequent metallization process.

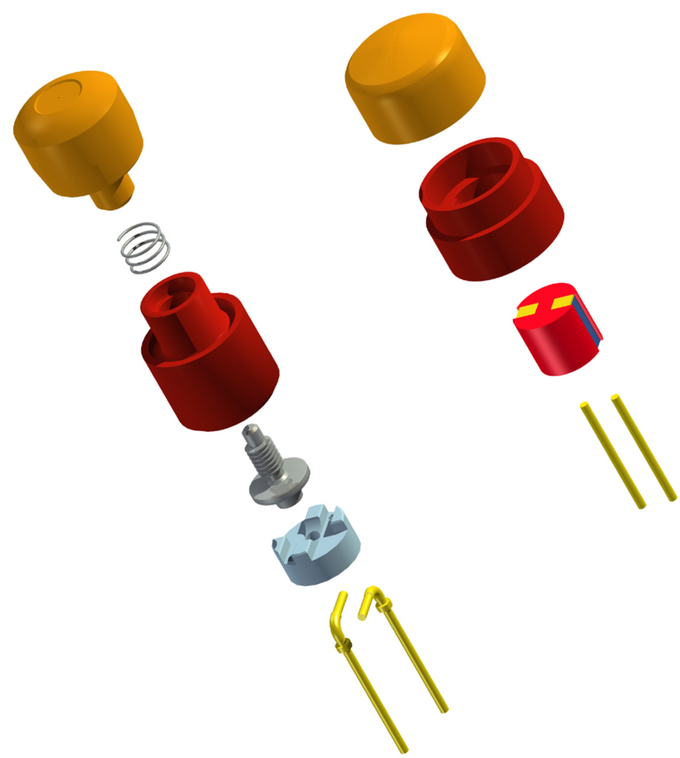

Figure 1. *Design of an on-off switch for a hearing aid. Left: Conventional design. Right: New design based on two-component (2C) molded interconnect device technology.*

The problems associated with bond strength and interface quality in 2C molding can be overcome with the right choice of materials, process parameters, material shot sequence, and also by smart design of 2C products. Detailed technical discussion of these issues is available

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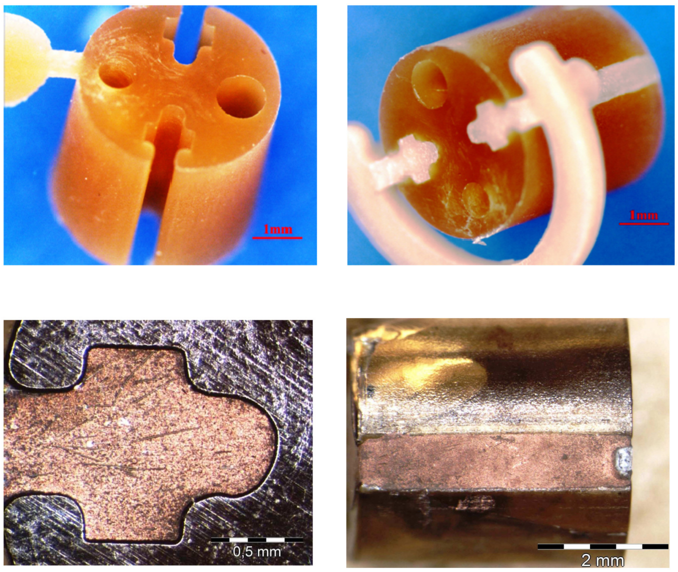

Figure 2. *Selectively metallized 2C-molded plastic part for a hearing aid on-off switch. Ultem PEI 1000 and Noryl GTX810 are polymer materials for injection molding.*

elsewhere.[1] For example, we have experimented with MID production using micro-based 2C molding. We optimized the choice of materials, process parameters, and molding shot sequence to obtain a well-defined interface and sufficient adhesion. We were also able to selectively metallize the plastic part. The result is a new design for an on-off switch for a hearing aid that has potential for low-cost, high-volume production. Figure 1 shows the comparative design of the switch. Figure 2 shows the selectively metallized 2C core part for the device.

Micro-MID fabrication by 2C molding requires modification of materials, processes, and parts design beyond polymer-polymer bond strength and the plastic interface.[1] The high surface-area-to-volume ratio of microproducts changes the wettability, friction, adhesion, and thermal interaction between the second-shot polymer melt and the first-shot substrate. Especially for micro-MIDs, the quality of the interface between plastics is more important than the adhesion between them. A polymer material with poor natural adhesion may be ill suited to macro products, but it may still work very well in 2C micromolding because of the size effect of the surface. More importantly, selective metallization benefits from the absence of an interfacial mixing zone in the case of a poorly adhering material pair.[2]

2C molding is growing rapidly and advancing from the macro to the micro area. Intelligent use of the technology offers cost-effective and industrially adaptive solutions to many technical problems. It can potentially replace polymer welding and manual assembly for a wide range of plastic product categories. The quality of 2C-molded parts can often be optimized by tuning the factors described here. The success of current work is paving the way to microapplications, including MID fabrication. Our next research objective is to test the feasibility of integrated micro-insert and 2C-molding techniques for multimaterial applications. We also plan to further investigate the ejection problems associated with microinjection molding and to produce high-aspect-ratio microstructures using reverse-2C molding.

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Aminul Islam received his PhD from the Technical University of Denmark in 2008. His research is mainly focused on two-component injection moulding, micro injection moulding, and the developing convergent micro-manufacturing process for high-volume industrial applications.

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