Editorial corner – a personal view

Potential of ultrasound technology for the preparation of microdevices

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The demand of microfabricated systems is continuously increasing due to their wide range of applications in microfluidics, microelectronics and biomedicine. Processing of thermoplastics by ultrasounds as an energy source appears a promising and effective technology for the fabrication of micro-molded pieces.

The use of ultrasounds to weld polymeric materials has been well known for almost 50 years ([https://doi.org/10.1016/0041-624X\(74\)90082-1](https://doi.org/10.1016/0041-624X(74)90082-1)). Since then, several related technologies have been developed. For example, the fast and neat bonding characteristic of ultrasonic welding was combined with ultrasonic hot embossing to produce micro-features on polymer substrates (<https://doi.org/10.3390/mi2020157>). Ultrasonic thermoforming, punching and beading are other processes that also benefit from the plasticizing effect of ultrasounds. However, the great potential of ultrasonic micro-molding has only recently been described (<https://doi.org/10.1007/s00542-011-1236-8>, <https://doi.org/10.1016/j.ultsonch.2013.07.007>). In this case, ultrasonic plasticization is combined with direct injection of the molten material into a small cavity (mold) by applying a force. This injection process is clearly facilitated by the physical effects of ultrasonic waves on the polymer melt rheology. Micro-molded pieces can be effectively fabricated in a single step using simple equipment fitted with a plasticizing chamber, a mold, a controller, an ultrasonic generator and an acoustic unit, which ultimately transfers the mechanical oscillations to the polymer sample.

Ultrasound micro-molding offers several advantages over conventional micro-injection processes: Short cycle times (around a few seconds), low polymer content in each cycle (around 200 mg), reduced amount of rejected material due to high dosage precision, potentially low degradation due to short exposure time to the energy source, low investment costs and low energy consumption. However, a number of problems limit the applicability of this technology. The most important ones are potential degradation in the plasticizing chamber due to high temperatures and cavitation associated with nucleation, growth, and violent collapse of microbubbles. Hence, careful control/selection of processing parameters is required for each type of polymeric material.

The potential of ultrasound micro-molding is enormous and continues to grow through the positive results reported in several research works, such as the possibility to prepare scaffolds by the salt leaching technique, drug-loaded samples and nanocomposites. Probably, one of the most promising results concerns easy production of exfoliated clay nanocomposites, even when the use of organo-modifiers is avoided (<https://doi.org/10.1016/j.ultsonch.2013.12.027>).

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