

## The revolutionary technology of 3D printing in the pharmaceutical field

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The aim of these works has been to deeply explore the possible uses of 3D printing technologies in the pharmaceutical field. 3D printing has been explored to produce pharmaceutical forms, medical devices, manufacturing devices, and analytical devices, all personalized based on the user's needs.

As medical device, we were able to efficiently produce antifungal 3D printed intravaginal rings using thermoplastic polyurethane and ethyl vinyl acetate loaded with clotrimazole, and bifonazole . These rings showed a sustained release and an efficient in vitro activity against *C. Albicans*, the pathogen generating vulvovaginal candidiasis. Moreover, direct printing of PHB was demonstrated for prolonged drug release devices .

As manufacturing tools, we developed 3D printed microfluidic devices using polypropylene (PP). Using them, we manufactured a wide library of lipid and polymer-based nanocarriers in a controllable and tunable way. Taking advantage of them, sucrose decorated anticancer liposomes .

Finally, as analytical device we created a 3D printed vertical diffusion cell that can be efficiently used instead of glass ones to evaluate both drug release and permeation .

3D printing has opened a new era in the pharmaceutical field. This has been possible thanks to the versatility of this innovative technology. We strongly believe that in the close future 3D printing will be efficiently integrated in pharmacies to formulate personalized medicines and that this technology will help the diffusion of personalized and low-cost manufacturing and analytical devices in research laboratories.