Characterizing and Reducing Cytotoxicity of 3D-Printed Polymers

Xi, Caimin (School: Adlai E. Stevenson High School)

Three dimensional (3D) printing technology has been generating over 14 billion USD in 2019 and is projected to grow to 35.6 billion USD by 2024. Leveraging high-resolution additive 3D manufacturing within the biomedical field is an advantageous tool with several important benefits, including: the customization of medical instruments, implants, and equipment; increased accessibility; improved cost-effectiveness; and vertical integration of design to manufacturing. While 3D printed metals and ceramics are already being utilized within the medical and life-science fields, 3D printed polymers—which composes of 82% of the 3D printing market and is the most accessible, timely, and cost-effective 3D printed material— have yet to be applied to biological devices due to its cytotoxicity, or toxicity to cells. Even though 3D printing was invented in the early 1980s, plastics polymers have continued to indicate the inability to interface with biologically active systems, and key features of biodegradability, cell attachment, cytotoxicity, and biocompatibility have yet to be well characterized. By measuring changes in cellular function upon direct and indirect exposure to four 3D printed polymers (Agilus, TangoPlus, ABS, VeroClear), we developed three cost-effective and accessible post-printing treatments that largely mitigates its toxicity and enables cell growth upon close contact: solid-liquid extraction treatment depletes toxic compounds such as monoacrylates and photoinitiators, UV light treatment completes the curing process to fully polymerize the resin, and PMMA overcoating creates a biocompatible barrier between the toxins and cells.