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Discovering Morphology Mapping with 3D printing at the NCD-SWEET Beamline at ALBA

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Direct digital manufacturing is a family of technologies which enables products to be manufactured directly from a digital definition without the use of specialized tooling or molds. Fused deposition modelling and stereolithography are probably the most common and widely used of these transformation technologies. These have developed out of techniques to rapidly produce prototypes of products from design or marketing ideas. Since their development, the range of materials used has widened to include materials from which actual products can be produced and which exhibit the properties required. Although there have been many advances in 3D printing technology, most of the focus has been on producing in hi-fidelity shapes from a digital definition. Little attention has been placed on developing technology to focus on other aspects beyond the simple form of a product. This work seeks to readdress this area.

Here, we focus on the use of 3D printing to produce plastic parts. Essentially, a thin strand of molten polymer is extruded onto a moving build platform in a defined manner to build up a structure layer by layer. As with any polymer processing technology, the process conditions will influence the polymer morphology and structure upon cooling which, in turn, will impact the properties. As part of a major project to fully understand all aspects of 3D printing, we performed small-angle X-ray scattering experiments on parts prepared in this manner on the NCD-SWEET beamline at the ALBA Synchrotron Light Source in Barcelona, Spain. We designed and built a 3D printer which can be mounted on the ALBA NCD-SWEET beamline so we can follow the structural development in real time. We will show examples of how the printing parameters affect the structure and morphology, we will describe the experiments which have been performed, and we will discuss the type of information we have been able to extract. We will show how the results we obtain can be used to optimize 3D printing technology and the materials used, and how this approach can be used to produce patterns or variations in properties by printing different morphologies –morphology mapping. In short, we will show how we can print properties, and not just shape and this will greatly extend the capabilities of 3D printing.

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