Use of Computed Axial Lithography as an In-Space Manufacturing Technology: Initial Verification Through Suborbital Testing

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Computed Axial Lithography (CAL) is a Volumetric Additive Manufacturing (VAM) method that forms all regions of a 3D printed part simultaneously utilizing photopolymer chemistry. CAL employs tomographic reconstruction to deliver an appropriate light dose to the volume to be cured into the desired geometry. Since the part cures volumetrically, as opposed to a layer-by-layer construction typically used in stereolithographic printing, printing time is greatly reduced, and a wider selection of printing materials can be used. CAL also enables overprinting, a process in which printed material is added onto an existing geometry. The part is materialized in a liquid medium and is suspended in place, negating the need for support material.

CAL is uniquely suited for In-Space Manufacturing (ISM) due to its fast printing times and complex geometry support. Additionally, since the print is generated within an enclosed volume, the print environment can be easily controlled and waste can be contained and properly disposed of. In a gravitational environment, the gradient change in density as parts form can cause them to shift during the printing process, leading to distortion and printing failure. This issue could be resolved in microgravity, reducing distortional failure in low-viscosity materials and increasing the feasibility of materials not traditionally viable on Earth.

An ISM version of CAL has the ability to repair existing tools and parts via overprinting, as well as printing organic tissue, lenses, and flexible seals. Two successful suborbital microgravity flight experiments have demonstrated CAL’s compatibility with low-viscosity materials, displaying an improvement in print quality relative to gravity-affected prints.