
Manufacturing in Space: a Challenge at the Crossroads of Material Science and Engineering

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Manufacturing in space represents more than a technological extension of terrestrial industry—it is a transformation of how we define and engineer matter. Beyond Earth's gravity well, materials behave, self-organize, and evolve under entirely new thermodynamic and kinetic regimes. Processes that are routine on the ground—solidification, phase separation, fluid transport, or sintering—become expressions of a different physics. This lecture explores this frontier where materials science and engineering merge into a single creative discipline aimed at constructing permanence in an impermanent environment.

By rethinking manufacturing as an adaptive and autonomous process responsive to vacuum, microgravity, and radiation, new paradigms emerge: self-assembling materials guided by electromagnetic or acoustic fields; fluids that encode functional order; alloys and composites that grow, heal, and morph under stimuli. These are not speculative visions, but emerging realities enabled by data-driven design, in-situ resource utilization, and microgravity experimentation platforms.

At this crossroads, manufacturing ceases to be production—it becomes genesis. It asks how humanity can craft matter to thrive beyond its native biosphere, transforming every atom of regolith, ice, or gas into architecture, tools, and life-support systems. Space manufacturing thus becomes the ultimate convergence point of scientific imagination and engineering discipline—a rehearsal for the sustainable future of civilization beyond Earth.
