Spacecraft, landers and rovers could be recycled for parts on the moon

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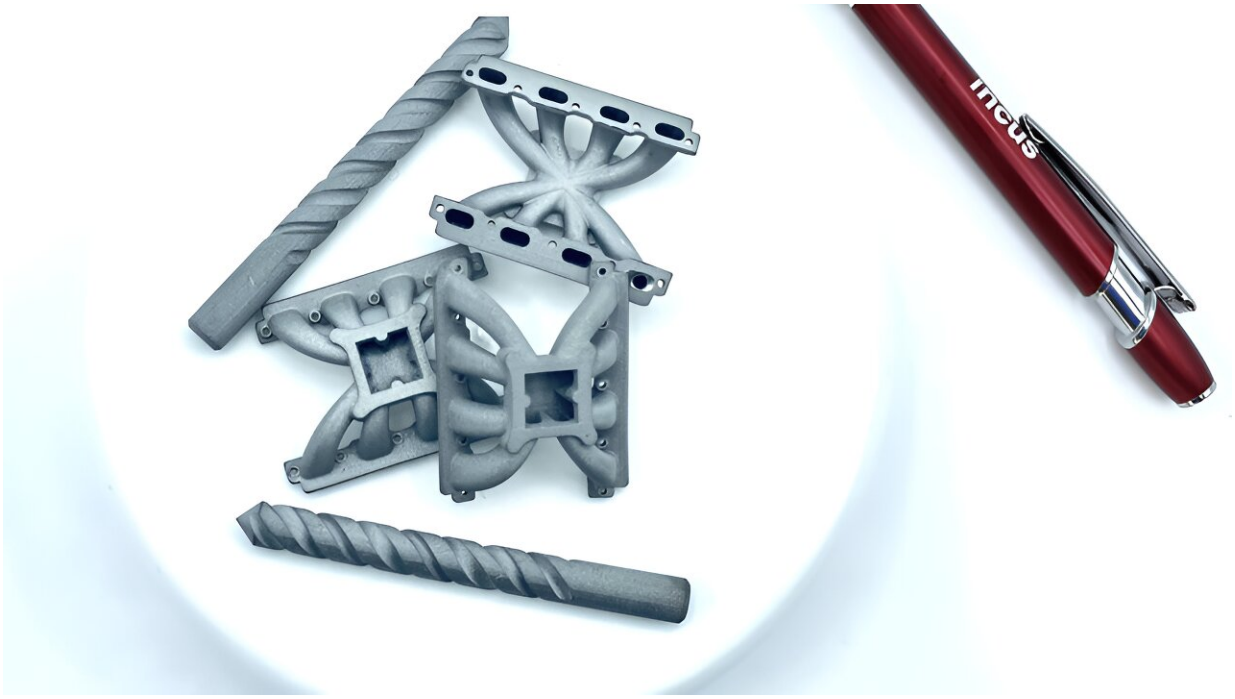

A pen alongside 3D printed parts that it could eventually be recycled into. Credit: Incus

Additive manufacturing is slowly becoming more and more useful as the technology improves. One of the places it continues its development is in the realm of space exploration. It has long been mooted as an integral part of any in-situ resource utilization (ISRU) efforts and is especially important for ensuring early explorers on the moon have the right tools

and materials they need to survive.

The European Space Agency is supporting that research effort, as their Technology Development Element fund supported work by an Austrian company called Incus to develop a 3D printing solution that could reprint metal parts on the moon.

The moon undoubtedly has plenty of metallic ore ready to be mined by either robots or explorers. However, making metal from that ore is expensive in energy and time, both of which are limited in any early lunar exploration scenario. So it would probably be better to use the much more straightforward process of recycling existing metal.

At least, that is the thinking underpinning the research done at Incus. The company uses a technique known as lithography-based metal manufacturing (LMM), which combines a metallic powder with a binding agent and then cures the resulting blend using ultraviolet light. Afterward, it is sintered together to make a completed part without all the waste of traditional "subtractive" manufacturing processes.

But on the moon, that process has an added challenge. As with all other competing processes, it has to deal with that most annoying of lunar substances—dust. Lunar dust is notorious for the problems it causes, and those problems extend to becoming ingrained in manufacturing processes like LMM. With too high of a dust concentration, the curing and binding don't work, and the metal parts that are being printed literally crumble back to dust.

This is particularly acute for recycling projects that would utilize metal from things like rovers and solar panels that would have been exposed to lunar dust for a significant amount of time. It would be impractical to clean them thoroughly before recycling them, mainly because of how notoriously sticky lunar dust can be. So, for processes like LMM, which

ideally use powder from recycled parts on the moon, there is a high likelihood of a significant fraction of lunar dust, rather than just metal, in that powder feedstock.

Incus set about trying to understand how much of a problem that was. Their ESA-sponsored research used both new and recycled titanium combined with a mix of different percentages of lunar dust. Titanium might be an expensive material here on Earth, but it will be even more valuable on the moon, as well as relatively common given its ubiquitous use in aerospace components. But how would it react to being reprinted into a part if its powder was integrated with up to 10% lunar dust?

Surprisingly well, in fact. Although high concentrations of lunar dust powder could affect the viscosity of the printed metal parts, varying the binder-to-powder ratio could ensure the parts would meet the same porosity standards as would be possible with injection molding processes back here on Earth.

That's not to say LMM is ready for prime time on the moon. Work remains for other types of material printing, such as iron/steel, and whether even higher concentrations of lunar dust might force a sort of filtration process before the metal can be recycled. ESA seems keen on continuing its support, so we might see more results from Incus and its partners soon.

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