

**NATURAL FEED-STOCKS FOR
FABRICATION OF SPARE PARTS =
SUSTAINABILITY FOR
PLANETARY MISSIONS**

Bonnie Cooper

David McKay

Presented by Dr. Tai Sik Lee

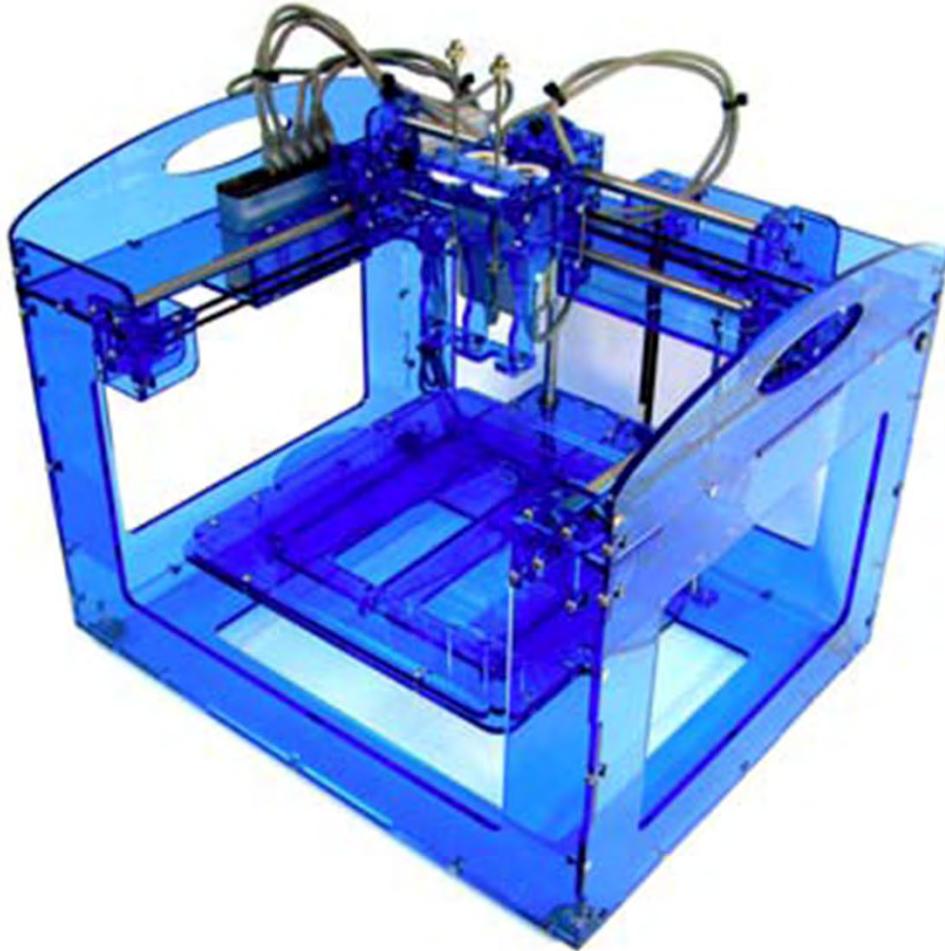
Greetings from Korea!

A breakfast fruit.
You must peel it before you can
eat it.

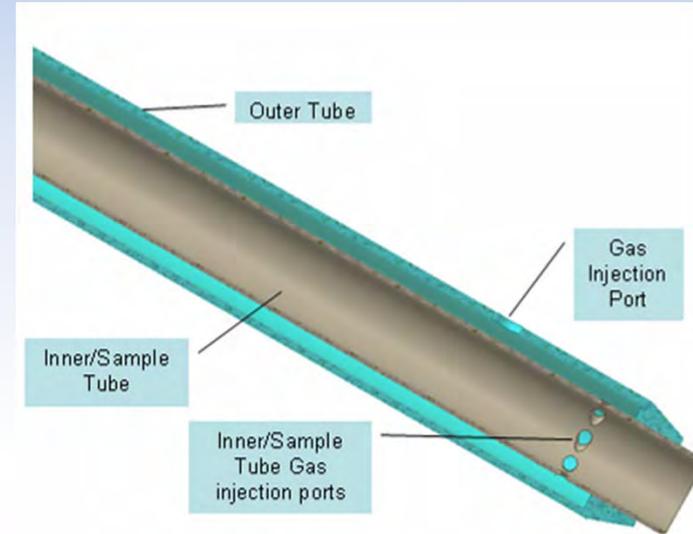
A photograph of a white plate on a textured placemat. The plate contains a spiky, reddish-brown fruit (likely a Korean chestnut or chestnut burr) in the center, a whole orange on the left, and a portion of another orange at the bottom. A silver knife is visible on the right side of the plate. The background is a light blue gradient.

Thanks to Dr. Tai Sik Lee for inviting me to Korea,
And for giving this talk.

Additive Manufacturing



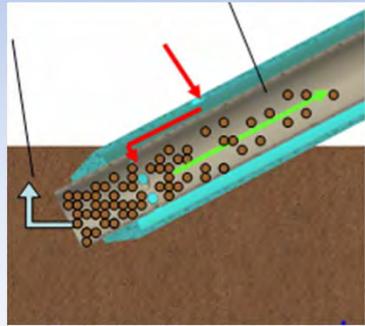
Feedstock Preparation



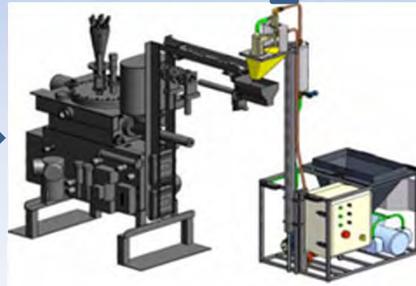
Zacny et al., 2008



Cooper et al., 2010



Pneumatic Transport



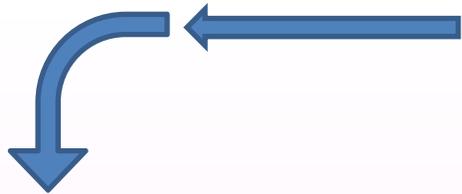
Oxygen Plant



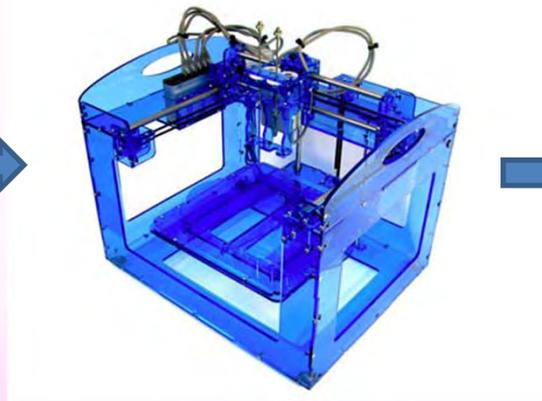
Fluidized Bed



Impactor/
Settling Flask



Cyclone



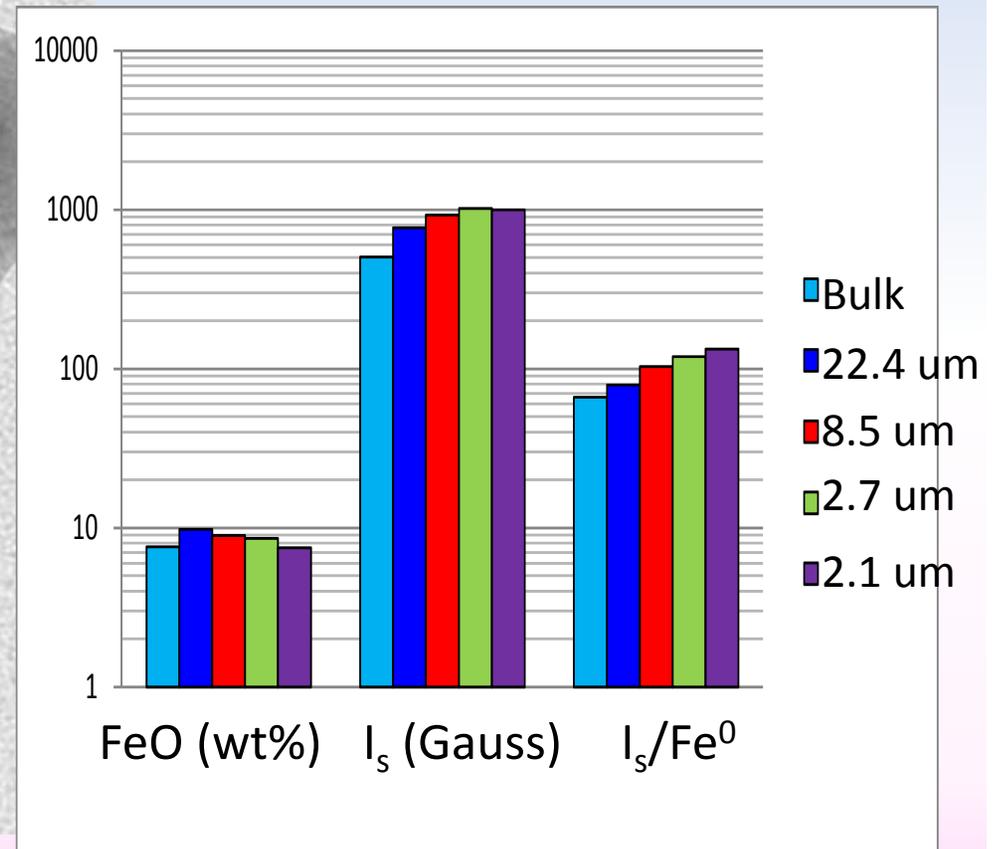
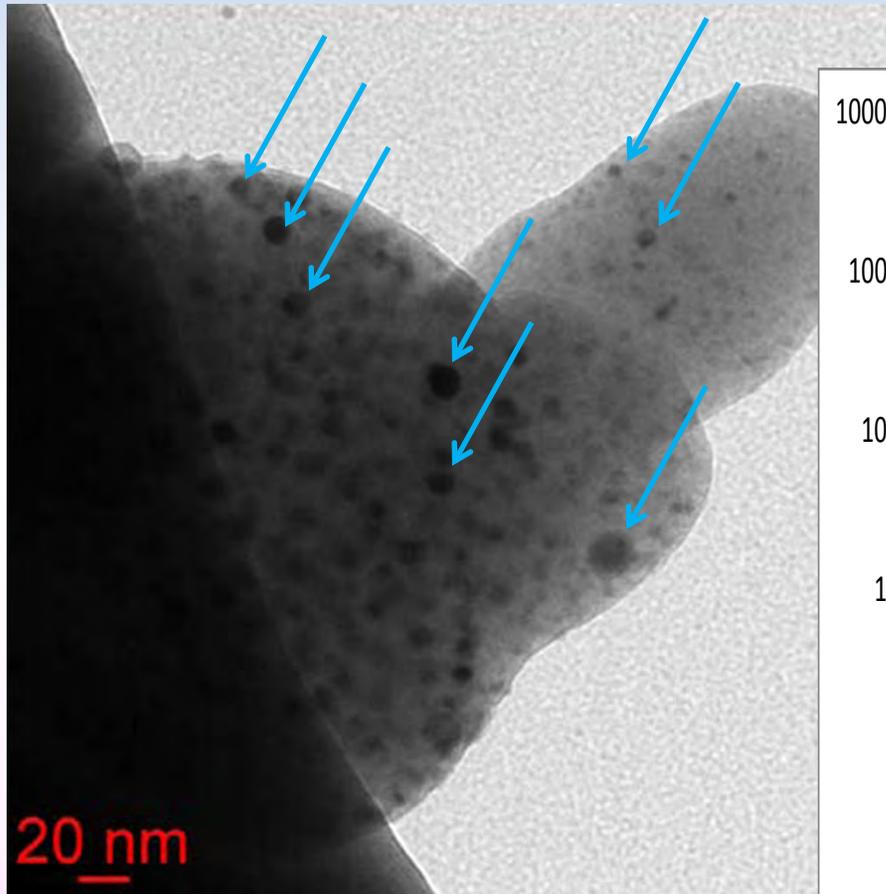
3D Printer



Useful Part



Native Iron Content of Lunar Soil

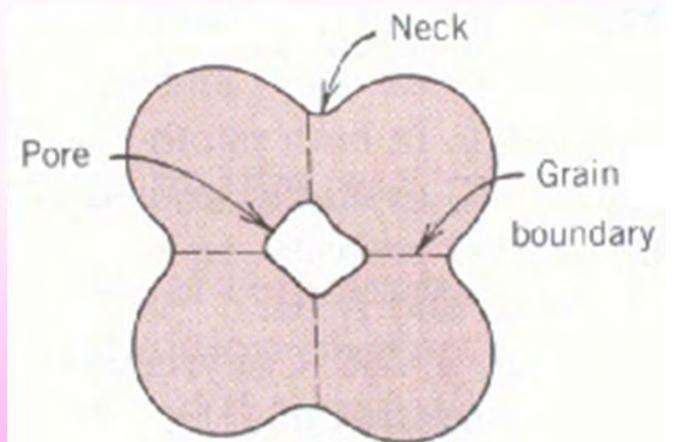


$FeO \neq Fe^0$!!!!!

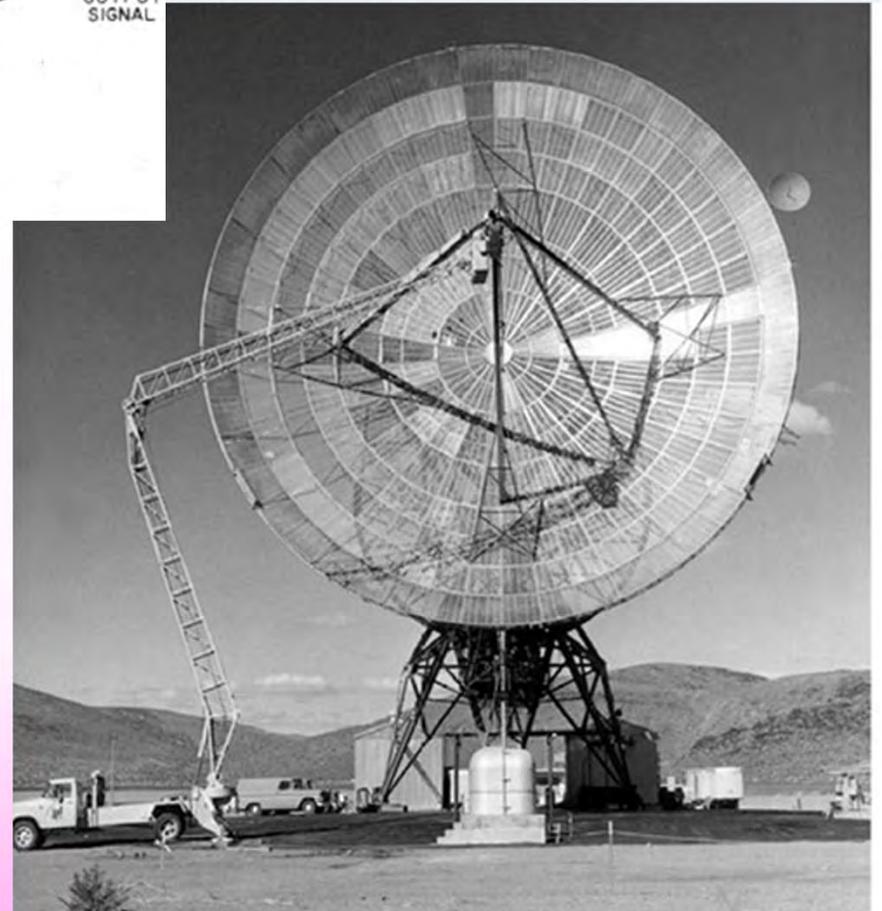
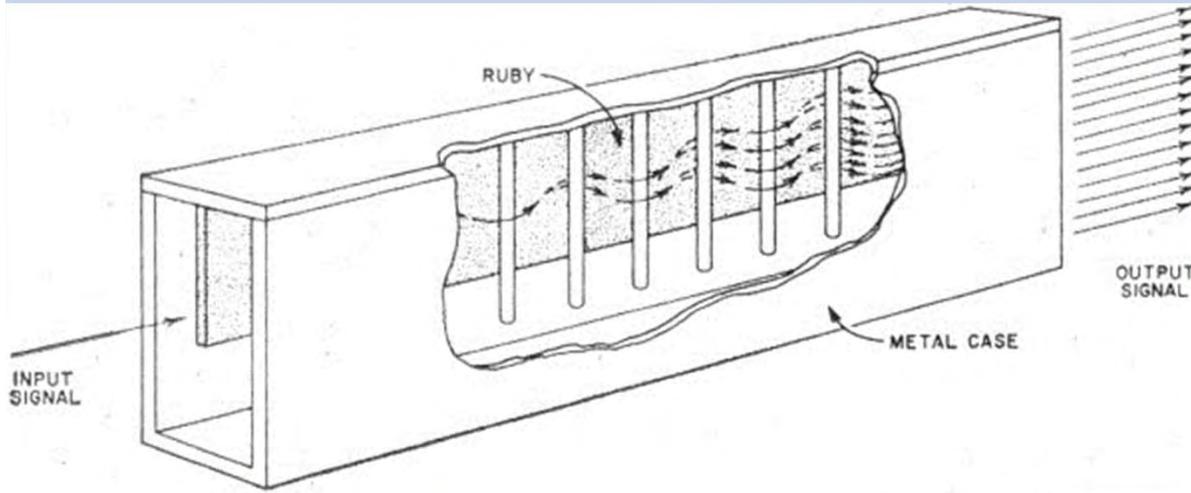
Submitted for publication, May 2013,
McKay, Taylor, Cooper and 6 others.

Native Iron Content of Lunar Soil

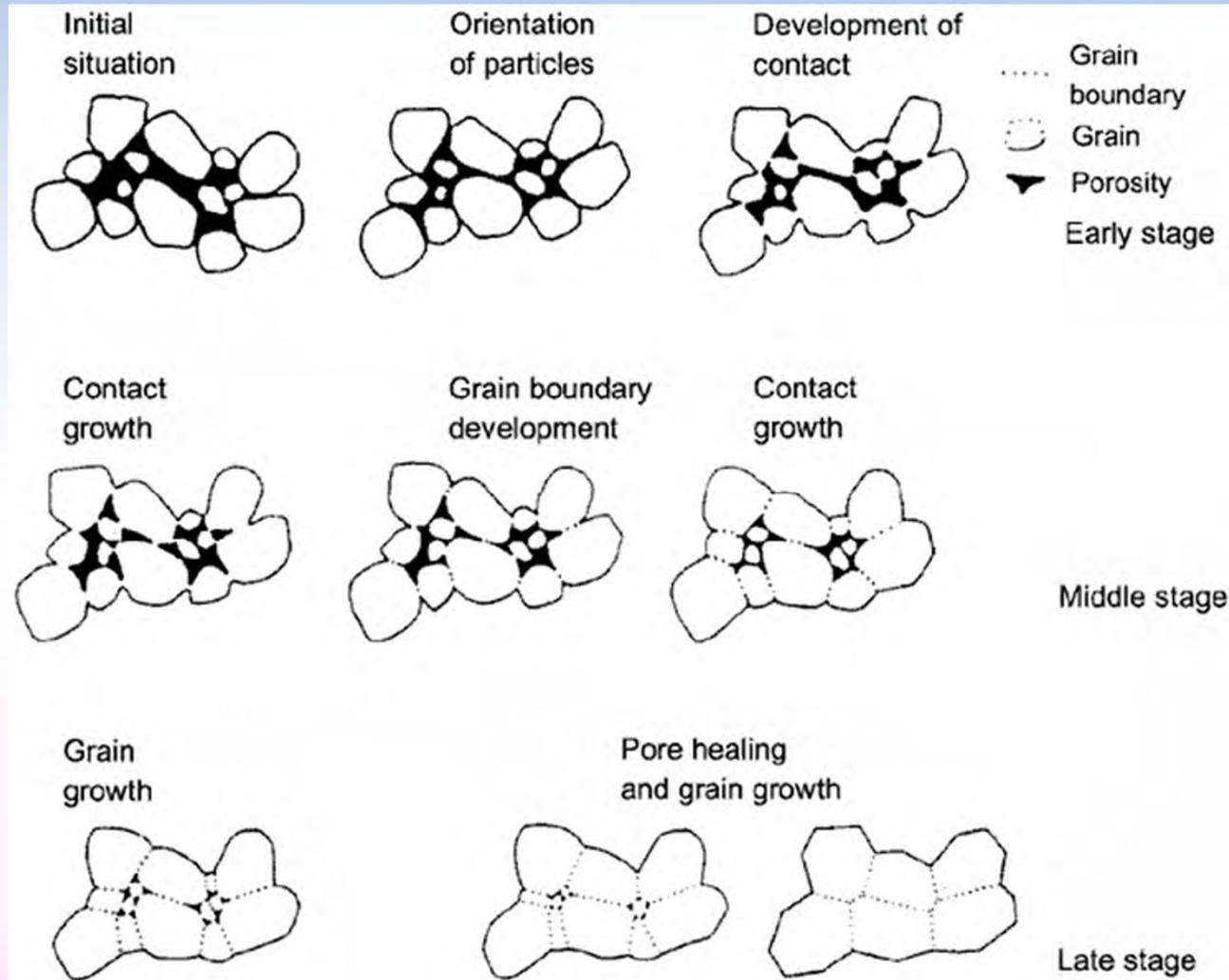
Material	Melting Point
Iron (Fe^0)	1127 - 1149 °C
FeO	1377 °C
Fe_2O_3	1566 °C
Fe_3O_4	1538 °C



Lasers and Masers



Microwave sintering of lunar soil



Taylor, L.A. and T.T. Meek, *Microwave Sintering of Lunar Soil: Properties, Theory, and Practice*. Journal of Aerospace Engineering, 2005. **18**: p. 188.

Conclusion

- 3D printing by fused deposition can be used on lunar soil.
- The soil can be precisely size-separated to make the 3D printing process work efficiently.
- Using a MASER instead of a LASER would allow us to use the finest fraction of lunar soil, AS-IS, to manufacture things on the Moon.