Figure 1

(a) Schematics of our custom-made sample holder for

the transfer of microscopic grains under N atmosphere ; (b) Sample transfer setup.

Figure 2

(a) Ryugu mm-size grain A0064, (b) seven microscopic grains picked from A0064 stone, resting on the gold mirror of sample holder #3, (c) visible image of one of the picked grains, A0064-FO023, (d) SEM image of A0064-FO023 (HV 2 kV - 50 pA - ICE detector)

Figure 3

SH3/A0064-FO020 in closed sample holder (through KBr window) (a) Optical image, (b) 2.7 μm feature (hydration feature) band area integrated on hyperspectral image from MCT/A detector with synchrotron source, (c) SEM image of the grain taken after having opened the sample-holderRyugu mm-size grain A0064, (d) spectra centered on the 2.7 μm hydration feature of the selected grain, acquired through the KBr window.

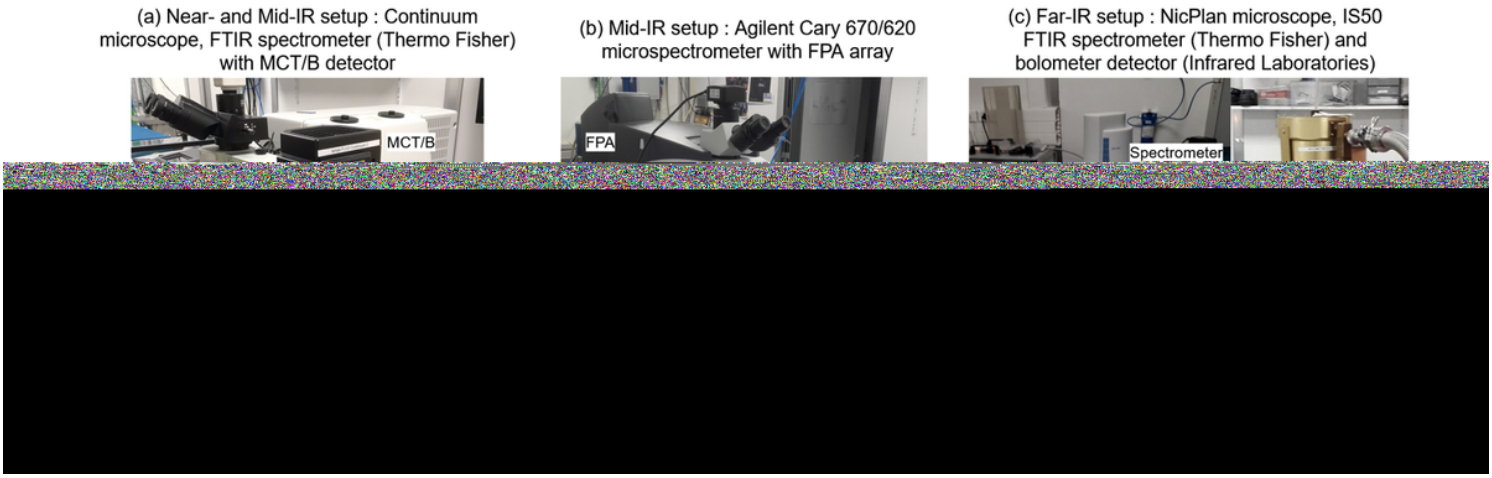

Figure 4

The different systems used and their respective spectral ranges

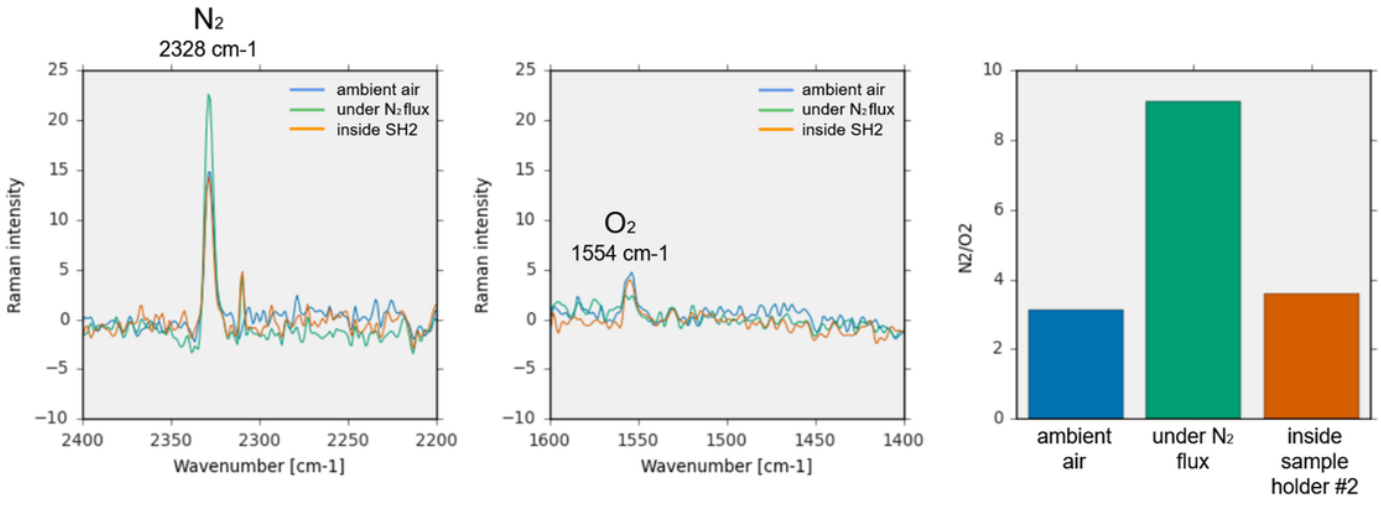

Figure 5

Raman spectra on SH2, detecting presence of both N₂ and O₂ inside, with an N₂/O₂ ratio similar to that of ambient atmosphere

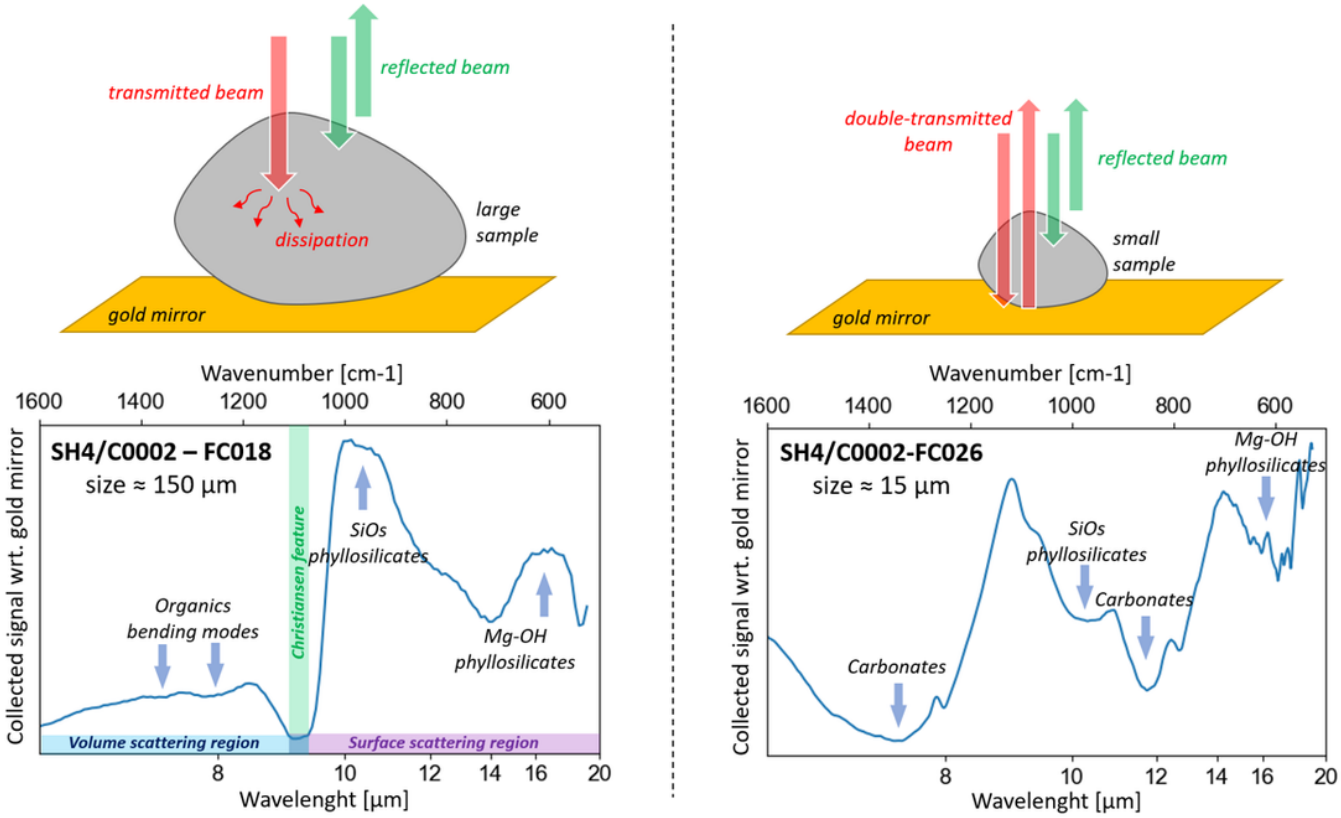

Figure 6

[left panel] cartoon modeling large grain behavior for infrared measurements on gold ; in the bottom panel, the collected signal with respect to a gold background from C0002-FC018, the largest grain in our set (size of approximately 150 µm). The collected signal behaves as expected from a standard reflectance measurement (spectral bands point downward before the Christiansen feature and upward after). [right panel] cartoon modeling large grain behavior for infrared measurements on gold, highlighting the contribution of a double-transmitted beam going through the sample and shining back towards the detector ; in the bottom panel, the collected signal with respect to a gold background from C0002-FC026, one the the smaller grains in our set (size of approximately 15 µm). The collected signal behaves erratically, with all the bands pointing downwards. The collected signal behaves like a transmission spectrum, even though it has been acquired in a reflectance configuration.

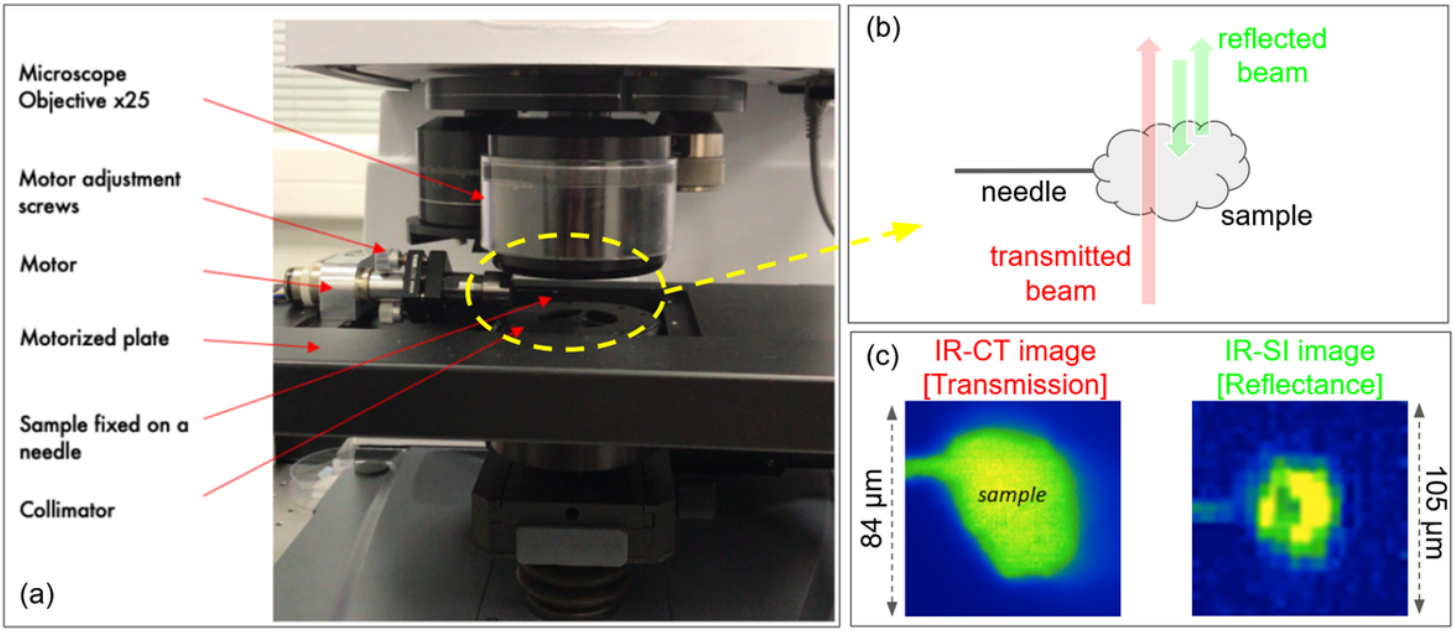

Figure 7

IR-CT and IR-SI principle of measurement. (a) description of 3D measurements setup pieces, (b) schematization of beam path for IR-CT measurements (transmitted beam) and IR-SI (reflected beam), (c) example of 1 hyperspectral image from IR-CT and IR-SI imaging techniques. The images shown in panel (c) correspond to the continuum signal at 2.7 µm transmitted (for IR-CT) or reflected (for IR-SI) by the sample. For IR-CT, 90 images are acquired, one every 2°, rotating the sample from 0° to 180° : the final dataset consists of 128x128x90 spectels (a spectel is the equivalent of a pixel for hyper-spectral imaging : only one value can be associated to a pixel, while a whole spectra can be associated to a spectel). For IR-SI, 18 images are acquired, one every 20°, rotating the sample from 0° to 360° : the final dataset consists of 32x32x18 spectels.

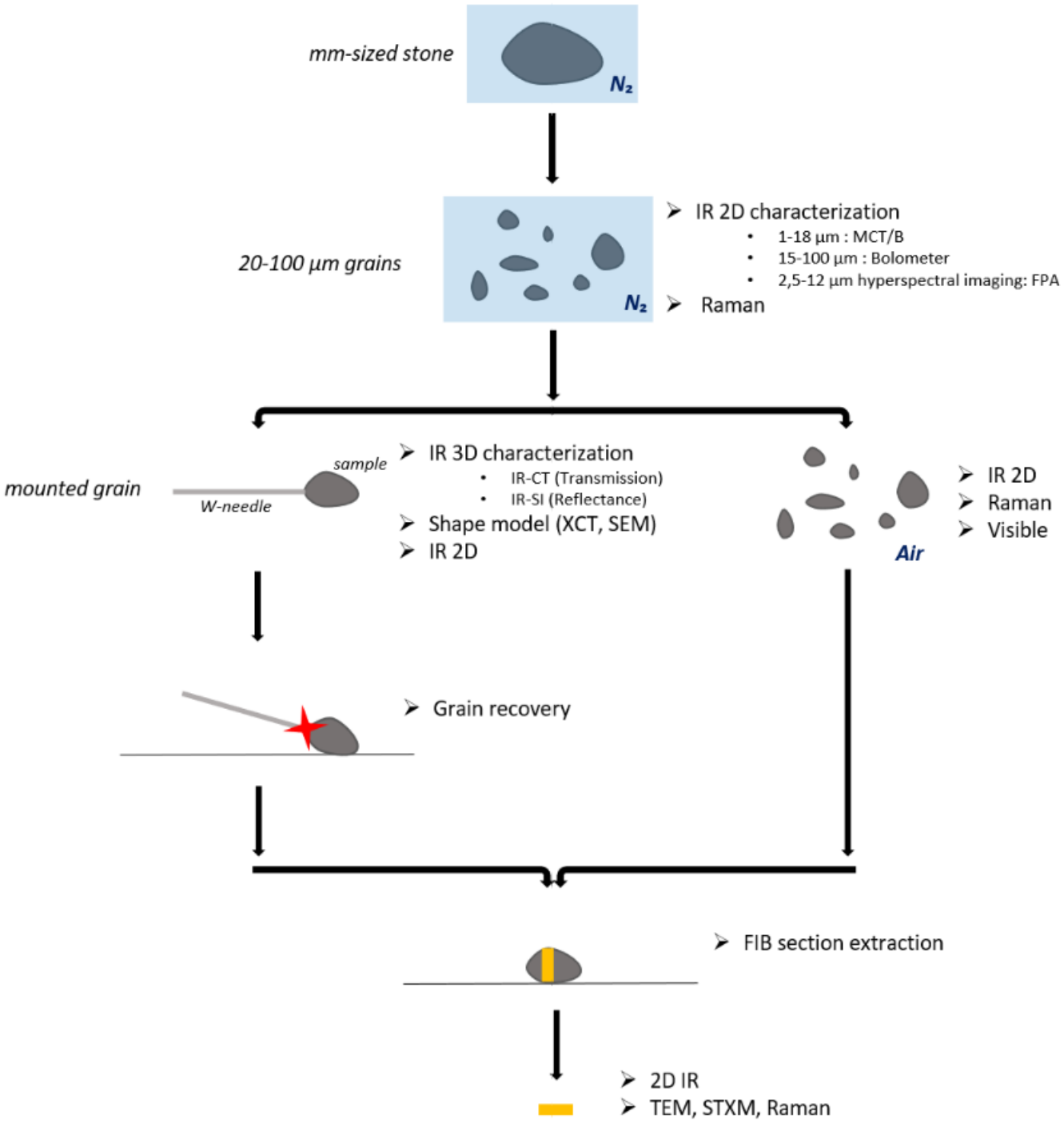

Figure 8

Cartoon summarizing the analytical pipeline used for Ryugu's particles. Note that everything is stored under a dry N atmosphere when not in this pipeline.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- graphicalabstractRubinoTechRep.png