Ice calibration line estimation method for future lunar polar exploration

Ryotaro Araki[1] and Kazuto Saiki[2]

[1] Department of Earth and Space Science, Graduate school of Science, Osaka University

[2] Earth and Space Exploration Center, Ritsumeikan University

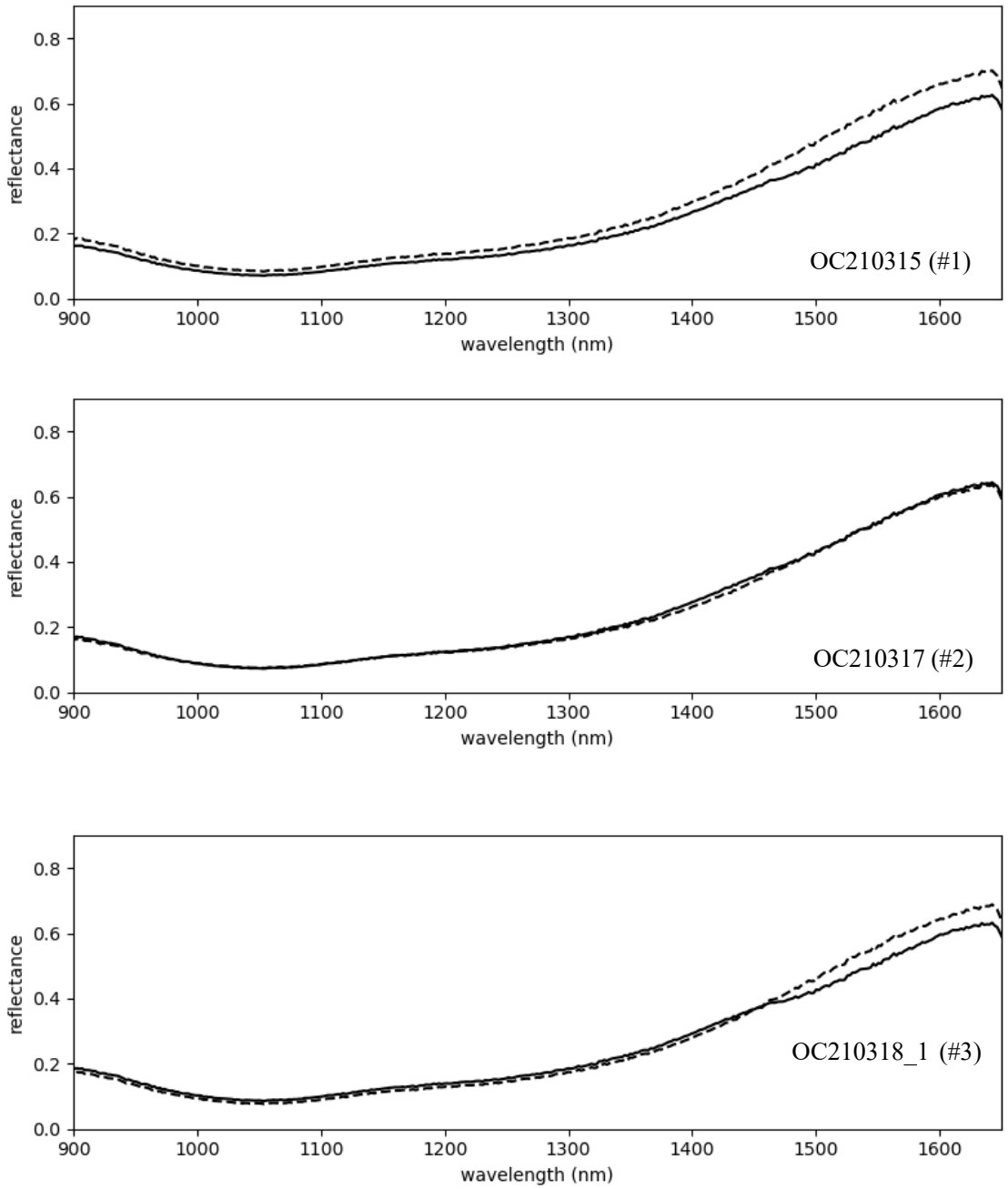
The data supporting the paper are organized within a data directory. The ‘Experimental Data’ folder includes spectra from each experiment, categorized into folders named ‘olivine’, ‘plagioclase’, ‘cpx’, and ‘mixture’. Within these folders, there are two subfolders for grain sizes ’75-125um’ and ‘180-250um’. Each of these subfolders further contain two folders. The ‘raw data’ folders contain the CSV files of spectral data from both frosted (xxxx_ice.csv) and dry (xxxx_dry.csv) samples in each experiment, prior to smoothing spline calculation. The ‘fitted data’ folders, on the other hand, contain CSV files of frosted spectra after the smoothing spline calculation has been applied. The correspondence between each CSV file name and its experimental content is listed in Table S1.

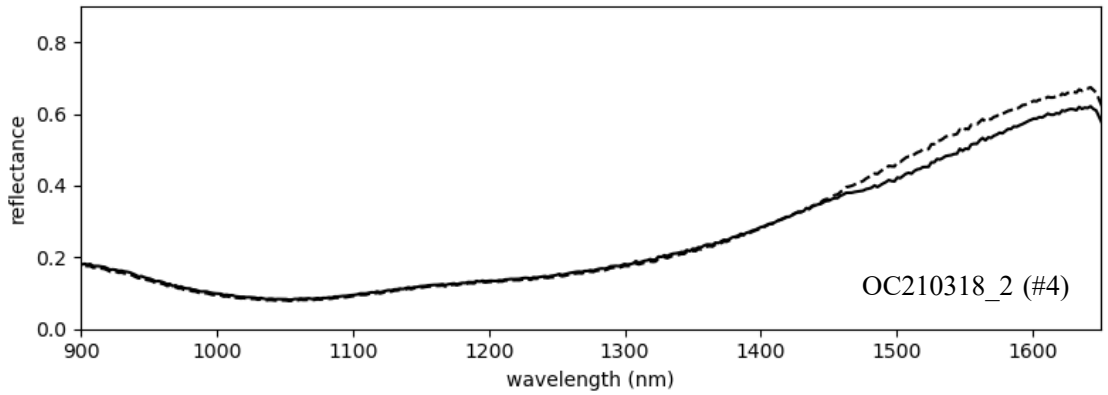
Table S1. A list of data file names and details of the samples observed in the experiment corresponding to that file.

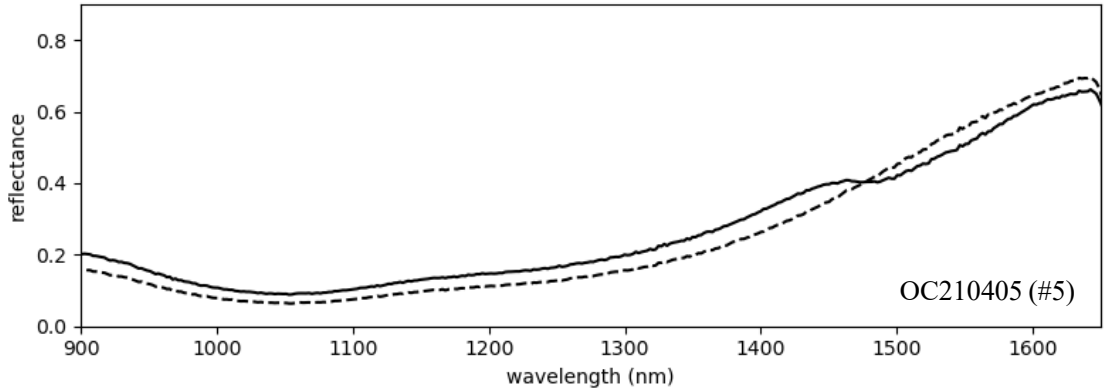
Spectral Data File Name	Run Number (Table 1 in manuscript)	Mineral Type	Particle Size (μm)	$M_{mineral+ice}$ (g)	$M_{mineral}$ (g)	M_{ice} (g)	amount of ice (wt.%)
OC201315	#1	Olivine	180 - 250 μm	2.652	2.635	0.017	0.65 ± 0.08
OC210317	#2	Olivine	180 - 250 μm	2.565	2.549	0.016	0.63 ± 0.08
OC210318_1	#3	Olivine	180 - 250 μm	2.323	2.302	0.021	0.91 ± 0.09
OC210318_2	#4	Olivine	180 - 250 μm	1.993	1.976	0.017	0.86 ± 0.10
OC210405_2	#5	Olivine	180 - 250 μm	2.381	2.334	0.047	2.01 ± 0.09
OF210319	#6	Olivine	75 - 125 μm	1.919	1.913	0.006	0.31 ± 0.10
OF210323_1	#7	Olivine	75 - 125 μm	1.800	1.792	0.008	0.45 ± 0.11
OF210323_2	#8	Olivine	75 - 125 μm	1.700	1.689	0.011	0.65 ± 0.12
OF210324	#9	Olivine	75 - 125 μm	1.620	1.591	0.029	1.82 ± 0.13
OF210407	#10	Olivine	75 - 125 μm	1.332	1.317	0.015	1.14 ± 0.15
OF230125	#11	Olivine	75 - 125 μm	1.721	1.714	0.007	0.41 ± 0.12
PC210329	#12	Plagioclase	180 - 250 μm	2.144	2.111	0.033	1.56 ± 0.09
PC210330_1	#13	Plagioclase	180 - 250 μm	1.751	1.726	0.025	1.45 ± 0.12
PC210331	#14	Plagioclase	180 - 250 μm	1.240	1.225	0.015	1.22 ± 0.16
PC210402	#15	Plagioclase	180 - 250 μm	1.909	1.896	0.013	0.69 ± 0.11
PC210405_1	#16	Plagioclase	180 - 250 μm	1.520	1.515	0.005	0.33 ± 0.13
PF210325	#17	Plagioclase	75 - 125 μm	1.649	1.641	0.008	0.49 ± 0.12
PF210326_1	#18	Plagioclase	75 - 125 μm	1.372	1.364	0.008	0.59 ± 0.15
PF210326_2	#19	Plagioclase	75 - 125 μm	1.657	1.649	0.008	0.49 ± 0.12
PF210327_2	#20	Plagioclase	75 - 125 μm	1.382	1.372	0.010	0.73 ± 0.15
PF210330_2	#21	Plagioclase	75 - 125 μm	1.059	1.038	0.021	2.02 ± 0.19
PF210401	#22	Plagioclase	75 - 125 μm	1.508	1.497	0.011	0.73 ± 0.13
CC211018_1	#23	CPX	180 - 250 μm	2.122	2.104	0.018	0.86 ± 0.10
CC211019	#24	CPX	180 - 250 μm	3.044	3.033	0.011	0.36 ± 0.07
CC211116	#25	CPX	180 - 250 μm	2.636	2.623	0.013	0.50 ± 0.08
CC211130	#26	CPX	180 - 250 μm	2.629	2.619	0.010	0.38 ± 0.08
CC220119	#27	CPX	180 - 250 μm	1.841	1.822	0.019	1.04 ± 0.11
CF211016	#28	CPX	75 - 125 μm	1.632	1.618	0.014	0.87 ± 0.12
CF211018_2	#29	CPX	75 - 125 μm	1.538	1.529	0.009	0.59 ± 0.13
CF211025	#30	CPX	75 - 125 μm	1.149	1.145	0.004	0.35 ± 0.17
CF211026	#31	CPX	75 - 125 μm	1.553	1.526	0.027	1.77 ± 0.13
CF211101	#32	CPX	75 - 125 μm	1.231	1.223	0.008	0.65 ± 0.16
CF211102	#33	CPX	75 - 125 μm	1.062	1.053	0.009	0.85 ± 0.19
CF211115	#34	CPX	75 - 125 μm	1.438	1.432	0.006	0.42 ± 0.14
CF211119	#35	CPX	75 - 125 μm	0.952	0.938	0.014	1.49 ± 0.21
MC220427	#36	Mixture	180 - 250 μm	1.911	1.878	0.033	1.76 ± 0.11
MC220430	#37	Mixture	180 - 250 μm	2.577	2.558	0.019	0.74 ± 0.08
MC220514_2	#38	Mixture	180 - 250 μm	1.899	1.876	0.023	1.23 ± 0.11
MC220516	#39	Mixture	180 - 250 μm	1.670	1.647	0.023	1.40 ± 0.12
MC220518	#40	Mixture	180 - 250 μm	1.514	1.503	0.011	0.73 ± 0.13
MF220428	#41	Mixture	75 - 125 μm	1.772	1.760	0.012	0.68 ± 0.11
MF220509	#42	Mixture	75 - 125 μm	1.919	1.909	0.010	0.52 ± 0.10
MF220514_1	#43	Mixture	75 - 125 μm	1.567	1.534	0.033	2.15 ± 0.13
MF220517	#44	Mixture	75 - 125 μm	0.848	0.841	0.007	0.83 ± 0.24
MF221104	#45	Mixture	75 - 125 μm	1.614	1.601	0.013	0.81 ± 0.12
MF221111	#46	Mixture	75 - 125 μm	0.912	0.897	0.015	1.67 ± 0.22

Figure S1. The NIR spectra obtained from experiments prior to the smoothing spline calculation. In each experiment, the solid lines represent frosted mineral spectra and dashed lines represent the spectra of dry minerals (after heating with no ice adhered).

(a) olivine data (ϕ = 180-250 um)







CSV data list (located in the folder path ‘Experimental Data’ > ‘olivine’ > ‘180-250um’ > ‘raw data’)

OC210315_dry.csv and OC210315_ice.csv

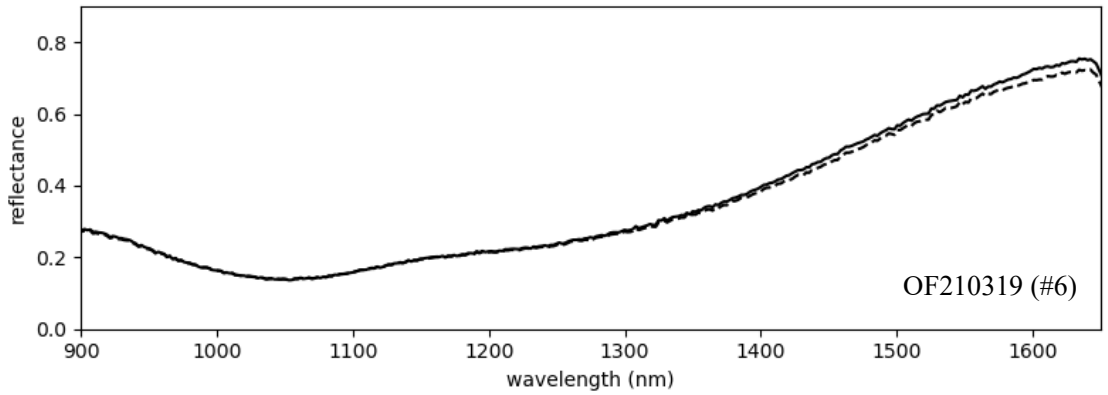
OC210317_dry.csv and OC210317_ice.csv

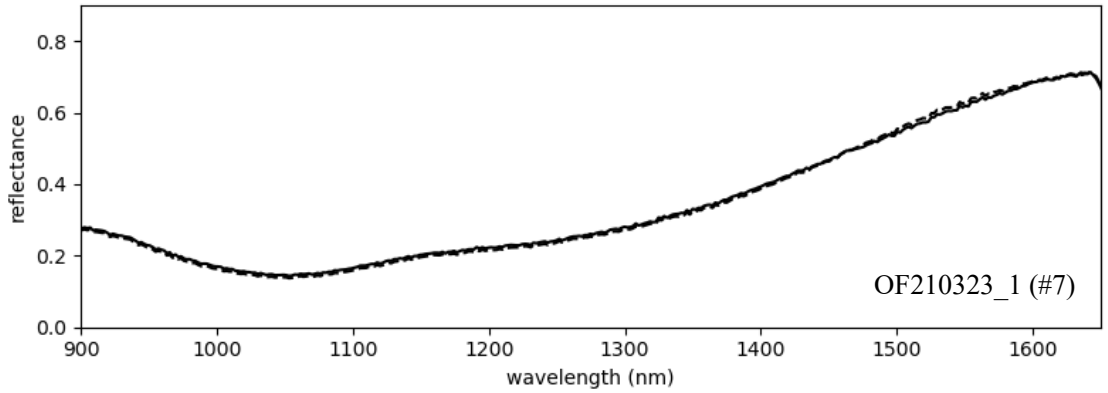
OC210318_1_dry.csv and OC210318_1_ice.csv

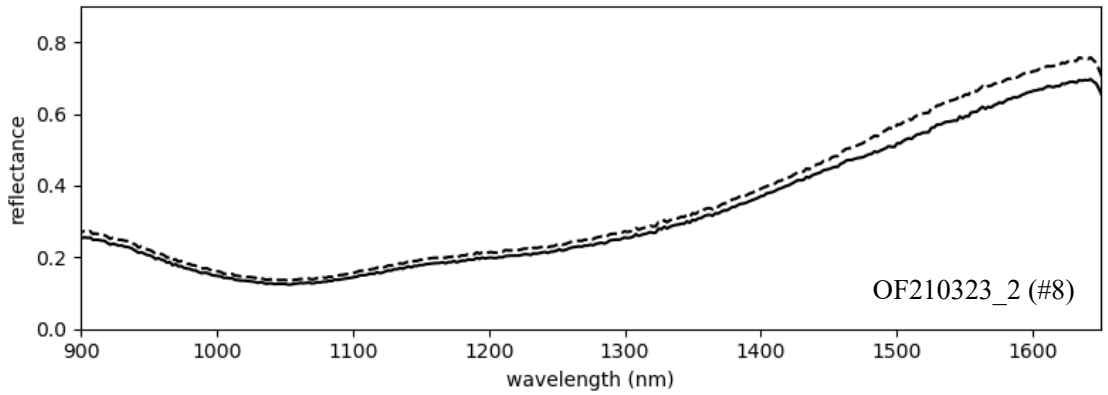
OC210318_2_dry.csv and OC210318_2_ice.csv

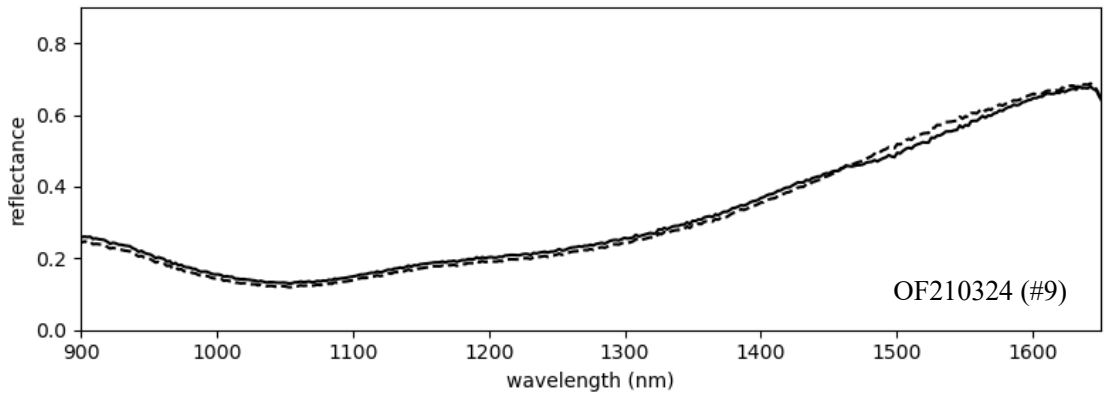
OC210405_dry.csv and OC210405_ice.csv

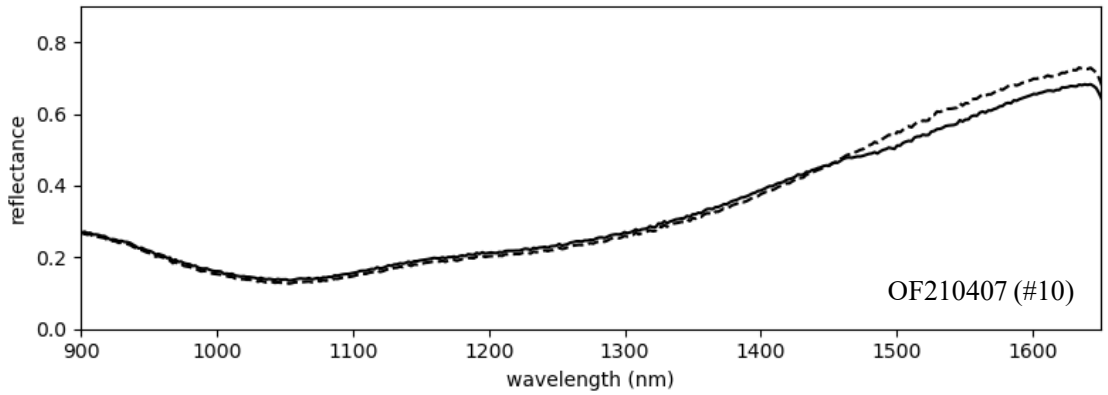
(b) olivine data (ϕ = 75-125 um)

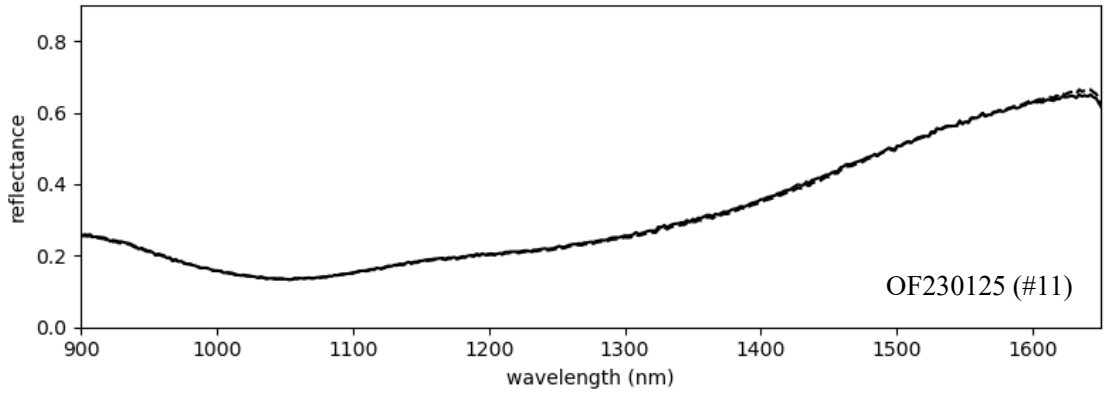

reflectance
0.0
0.2
0.4
0.6
0.8
900
1000
1100
1200
1300
1400
1500
1600
wavelength (nm)
OF210319 (#6)


reflectance
0.0
0.2
0.4
0.6
0.8
900
1000
1100
1200
1300
1400
1500
1600
wavelength (nm)
OF210323_1 (#7)


reflectance
0.0
0.2
0.4
0.6
0.8
900
1000
1100
1200
1300
1400
1500
1600
wavelength (nm)
OF210323_2 (#8)


reflectance
0.0
0.2
0.4
0.6
0.8
900
1000
1100
1200
1300
1400
1500
1600
wavelength (nm)
OF210324 (#9)





CSV data list (located in the folder path ‘Experimental Data’ > ‘olivine’ > ’75-125um’ > ‘raw data’)

OF210319_dry.csv and OF210319_ice.csv

OF210323_1_dry.csv and OF210323_1_ice.csv

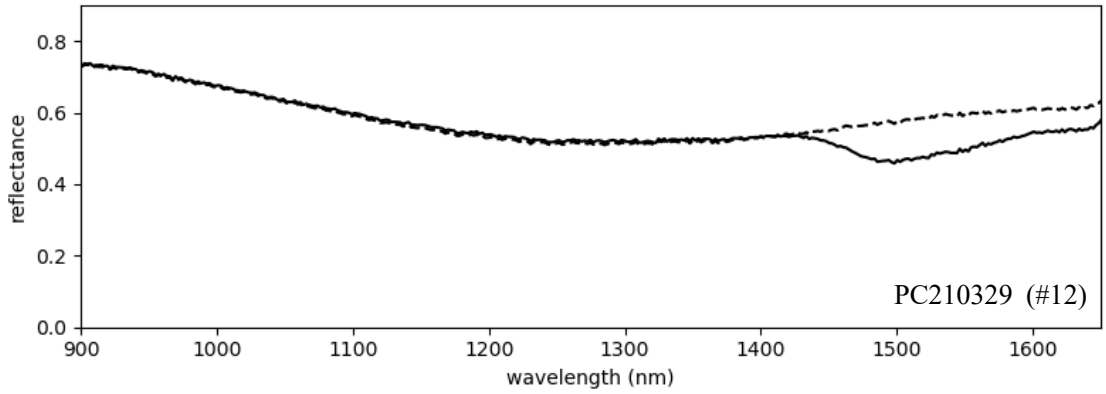
OF210323_2_dry.csv and OF210323_2_ice.csv

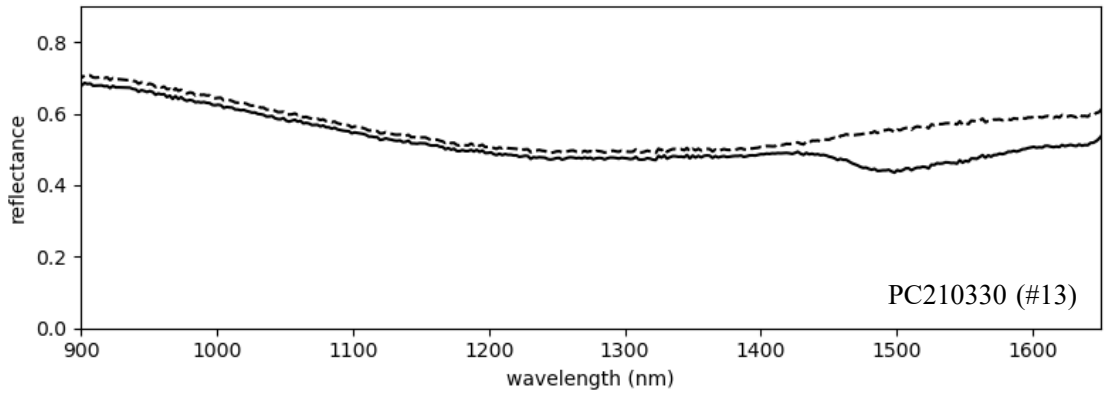
OF210324_dry.csv and OF210324_ice.csv

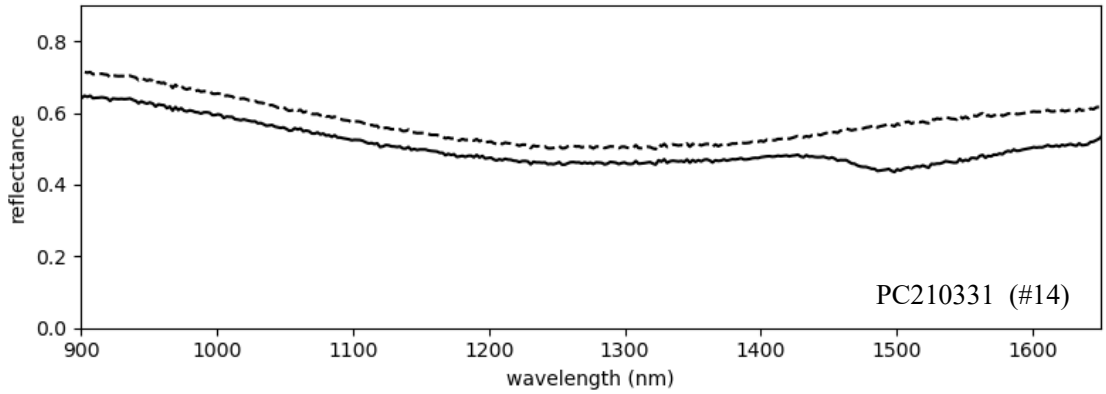
OF210407_dry.csv and OF210407_ice.csv

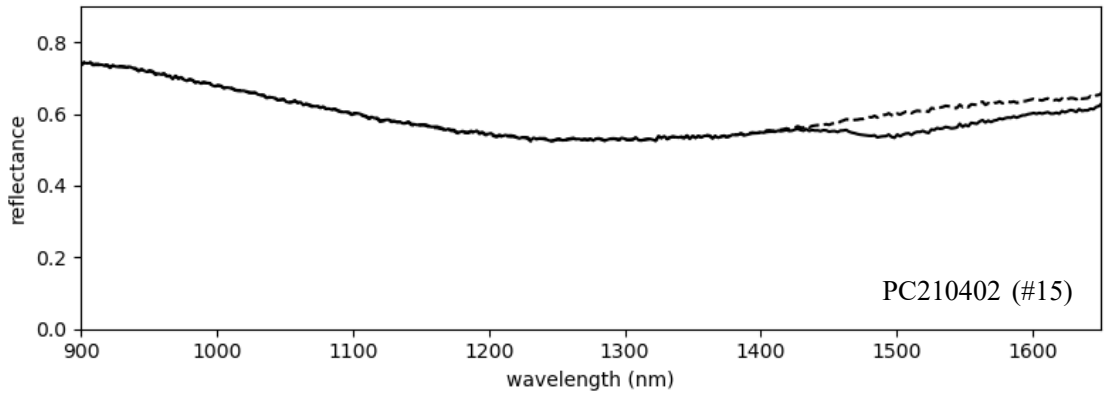
OF230125_dry.csv and OF230125_ice.csv

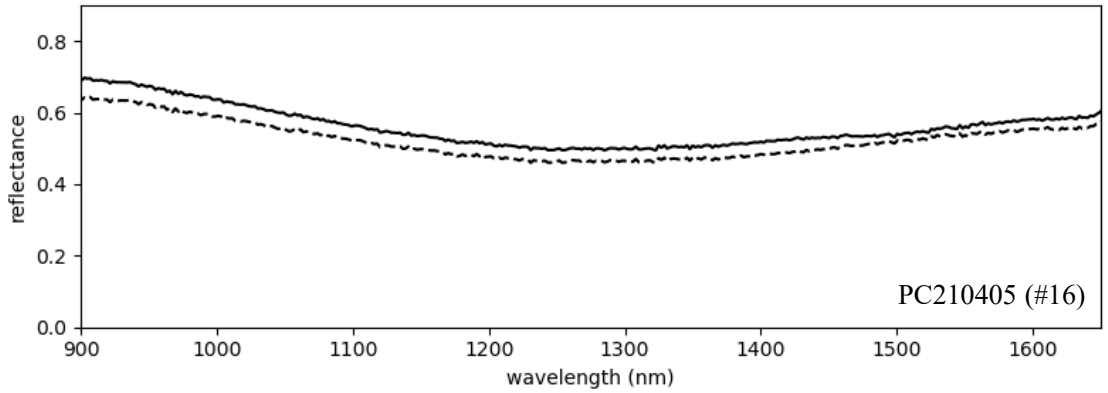
(c) plagioclase data (ϕ = 180-250 um)











CSV data list (located in the folder path ‘Experimental Data’ > ‘plagioclase’ > ‘180-250um’ > ‘raw data’)

PC210329_dry.csv and PC210329_ice.csv

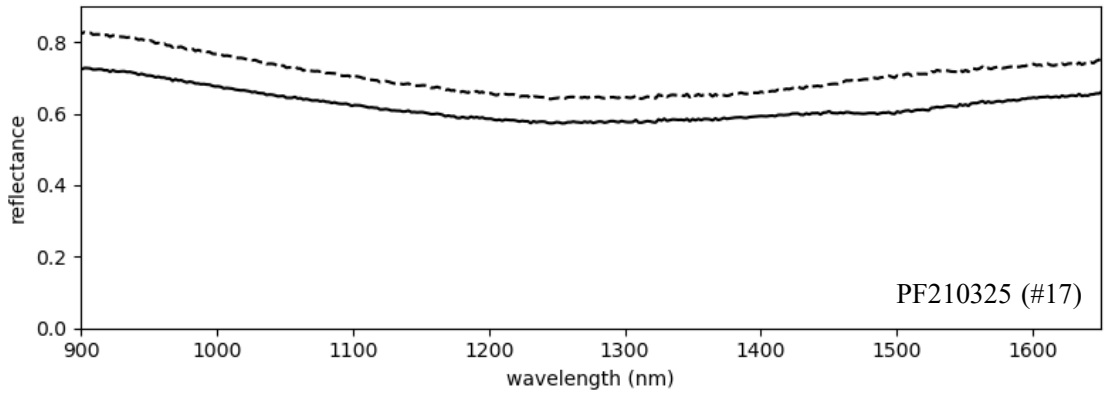
PC210330_dry.csv and PC210330_ice.csv

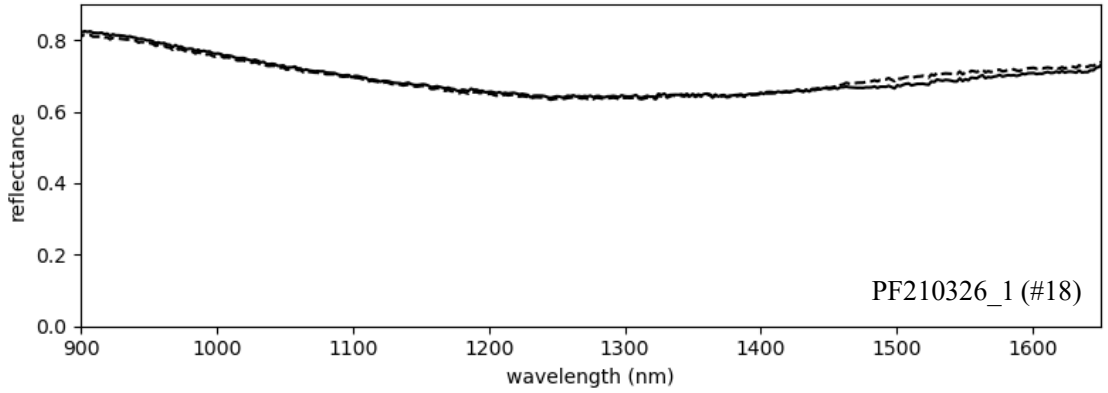
PC210331_dry.csv and PC210331_ice.csv

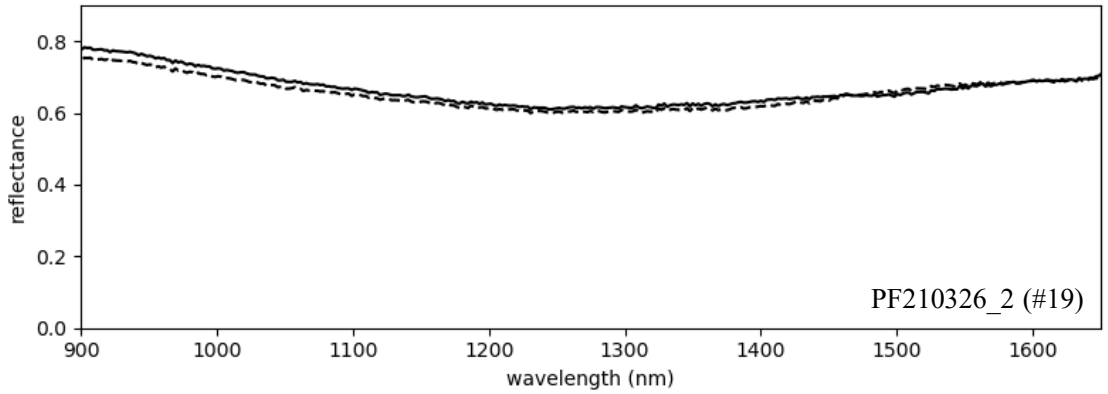
PC210402_dry.csv and PC210402_ice.csv

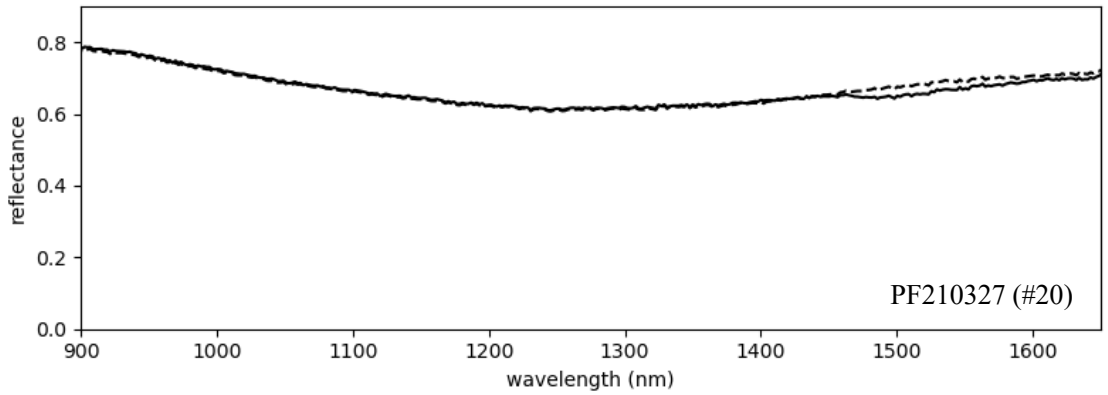
PC210405_dry.csv and PC210405_ice.csv

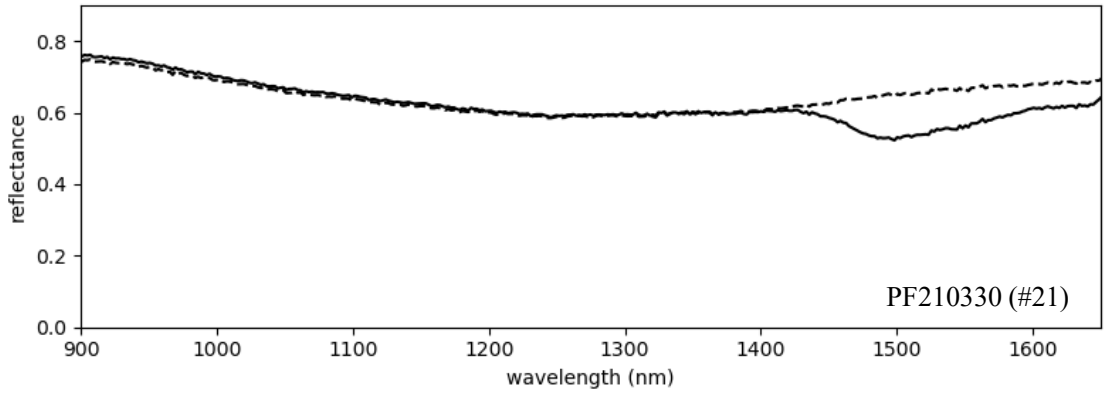
(d) plagioclase data (ϕ = 75-125 um)

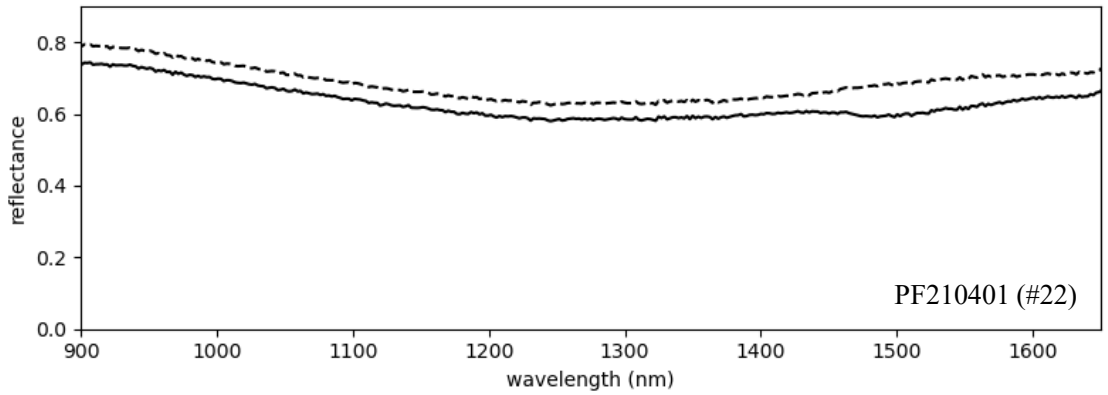












CSV data list (located in the folder path ‘Experimental Data’ > ‘plagioclase’ > ’75-125um’ > ‘raw data’)

PF210325_dry.csv and PF210325_ice.csv

PF210326_1_dry.csv and PF210326_1_ice.csv

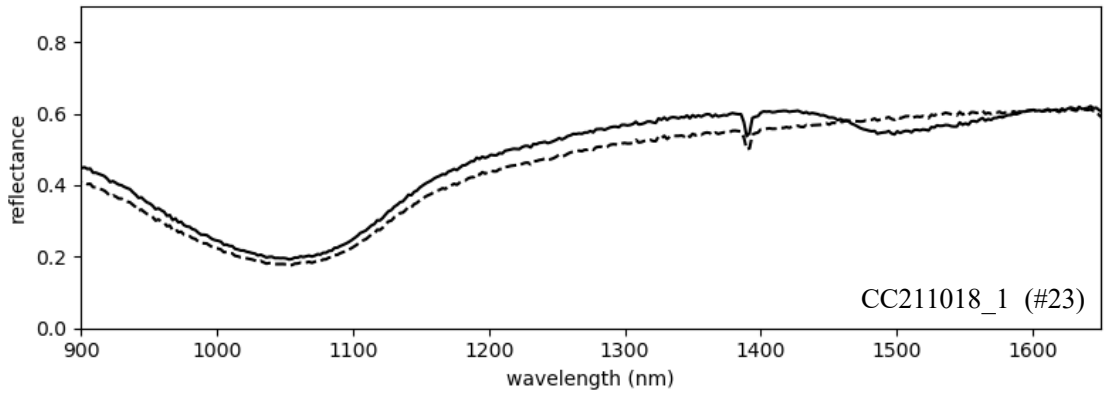
PF210326_2_dry.csv and PF210326_2_ice.csv

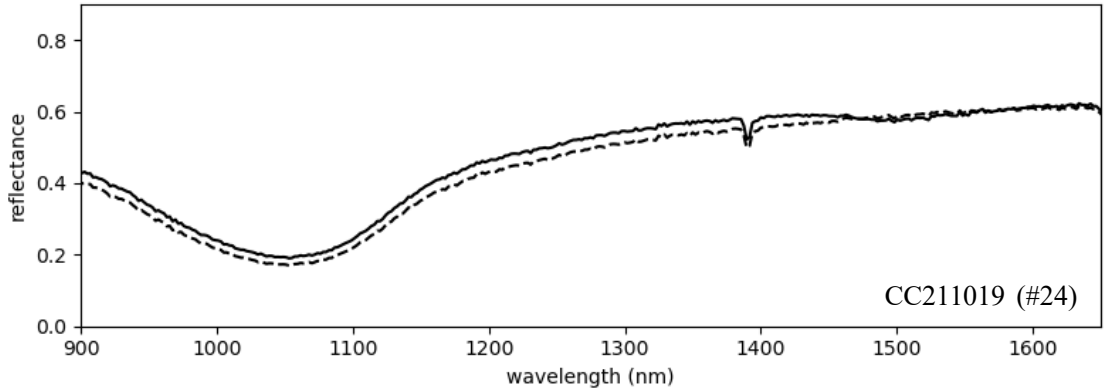
PF210327_dry.csv and PF210327_ice.csv

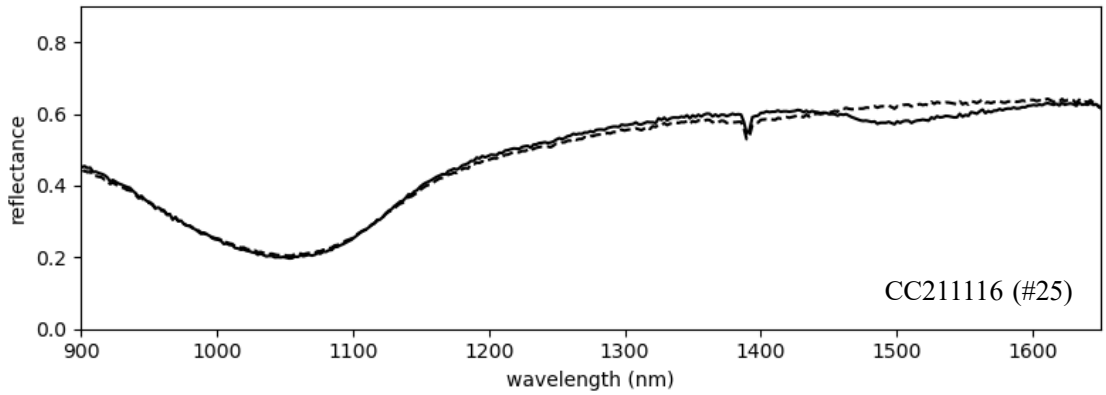
PF210330_dry.csv and PF210330_ice.csv

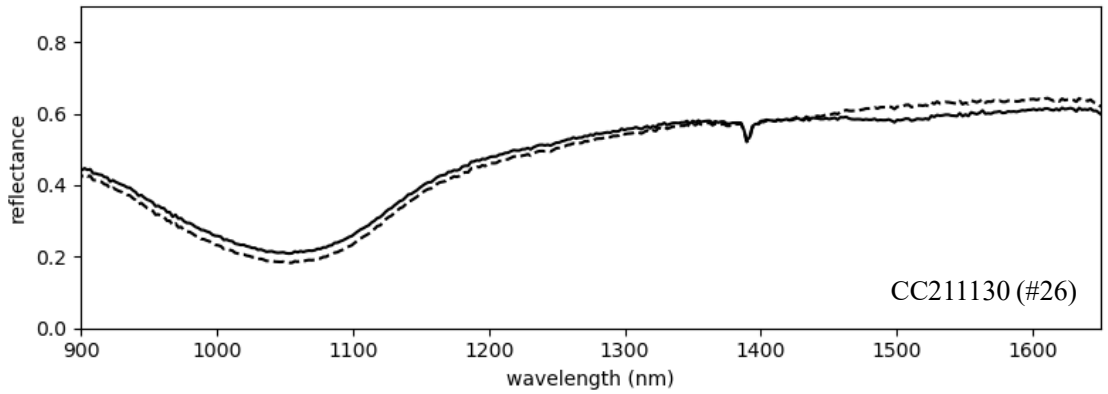
PF210401_dry.csv and PF210401_ice.csv

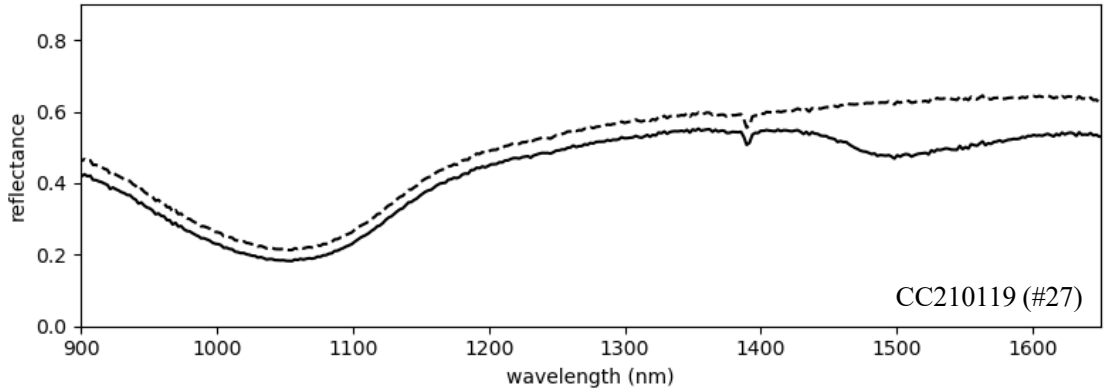
(e) cpx data (ϕ = 180-250 um)











CSV data list (located in the folder path ‘Experimental Data’ > ‘CPX’ > ‘180-250um’ > ‘raw data’)

CC 211018_1_dry.csv and CC 211018_1_ice.csv

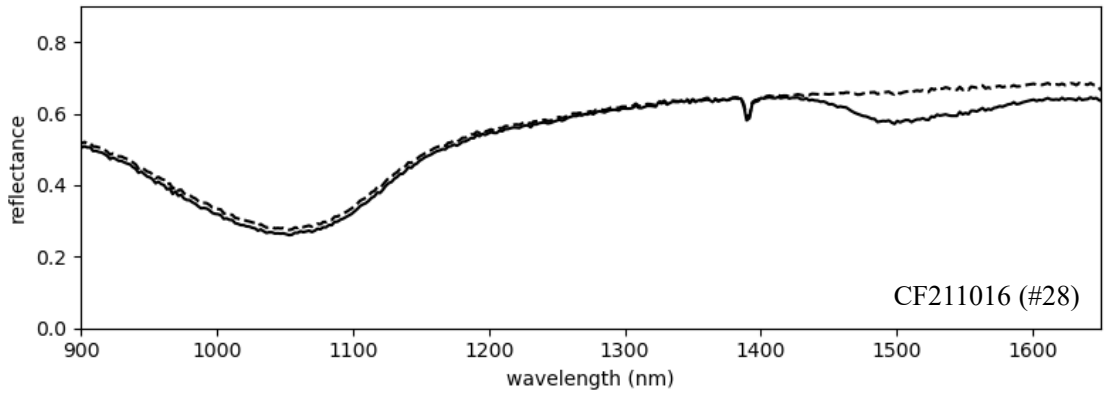
CC 211019_dry.csv and CC 211019_ice.csv

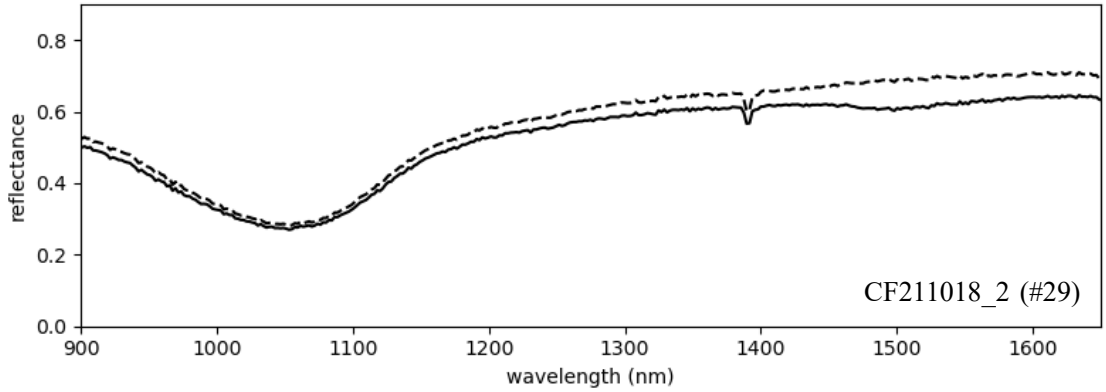
CC 211116_dry.csv and CC 211116_ice.csv

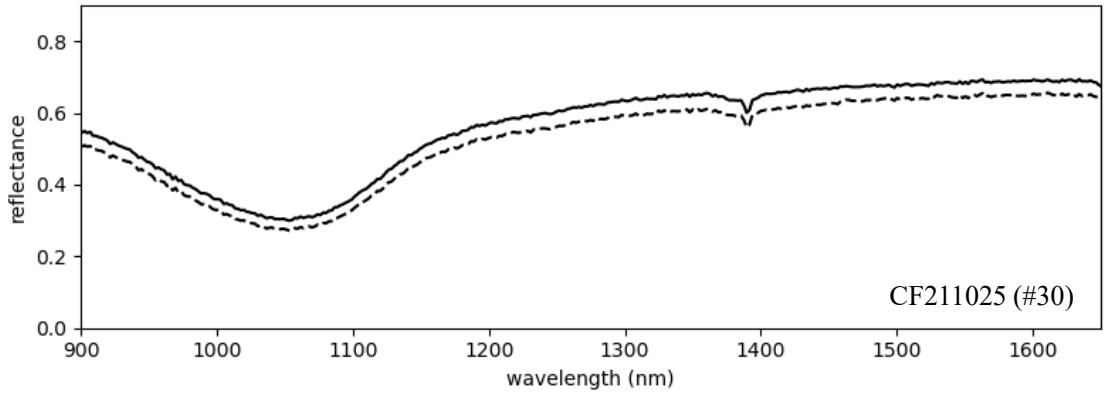
CC 211130_dry.csv and CC 211130_ice.csv

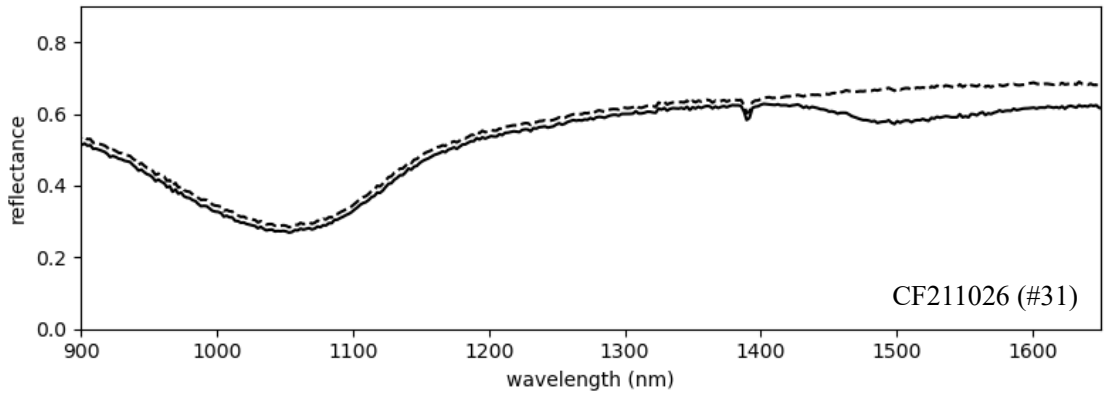
CC 220119_dry.csv and CC 220119_ice.csv

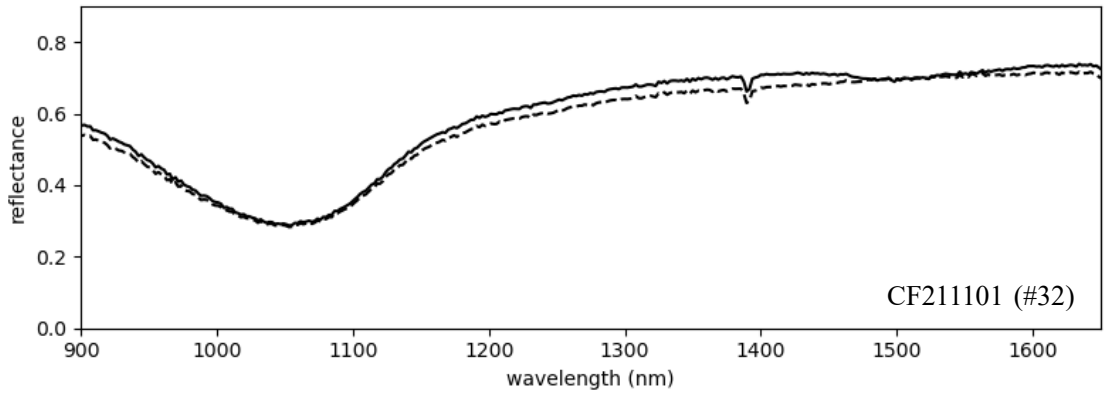
(f) cpx data (ϕ = 75-125 um)

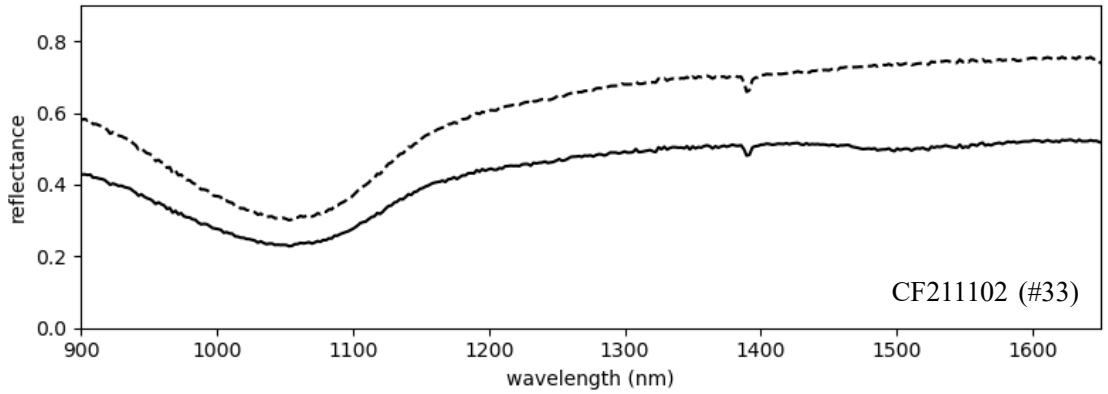


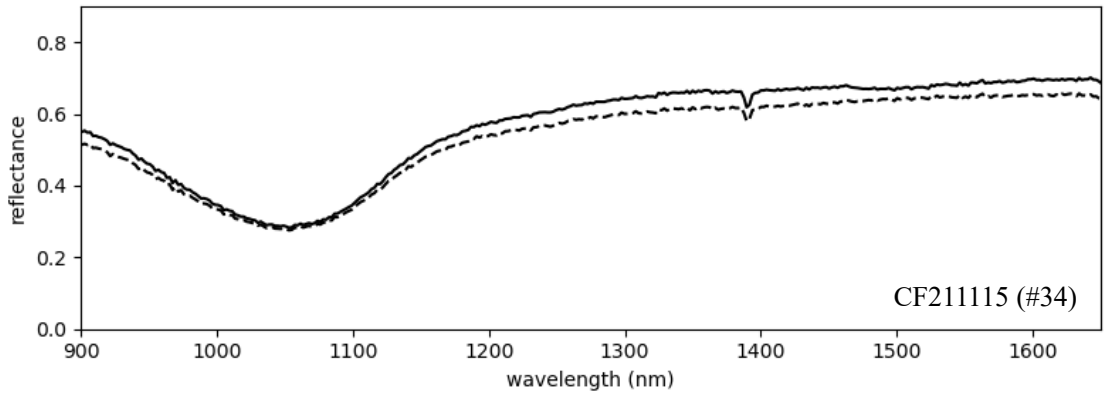


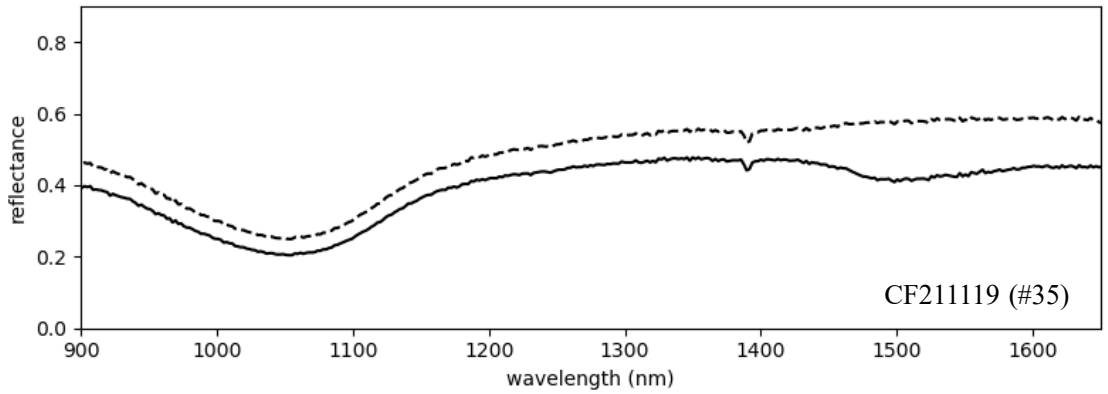



reflectance
wavelength (nm)
CF211026 (#31)


reflectance
wavelength (nm)
CF211101 (#32)


reflectance
wavelength (nm)
CF211102 (#33)





CSV data list (located in the folder path ‘Experimental Data’ > ‘CPX’ > ’75-125um’ > ‘raw data’)

CF211016_dry.csv and CF211016_ice.csv

CF211018_2_dry.csv and CF211018_2_ice.csv

CF211025_dry.csv and CF211025_ice.csv

CF211026_dry.csv and CF211026_ice.csv

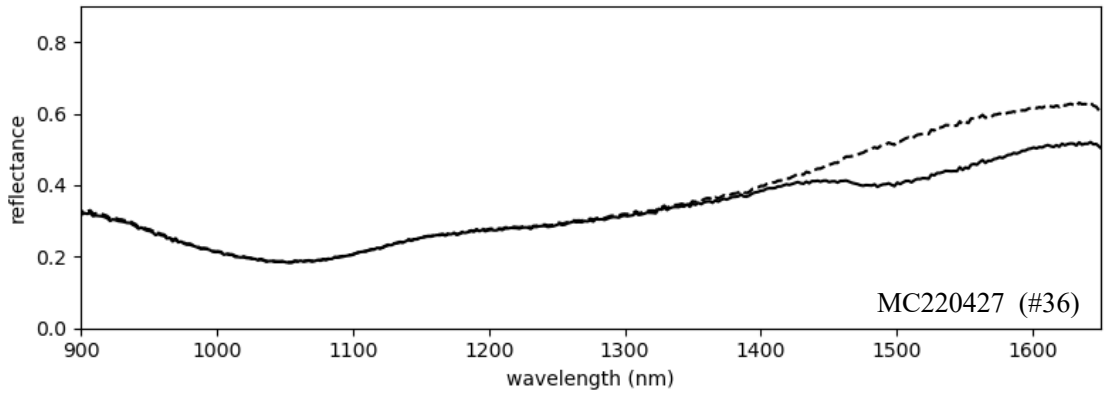
CF211101_dry.csv and CF211101_ice.csv

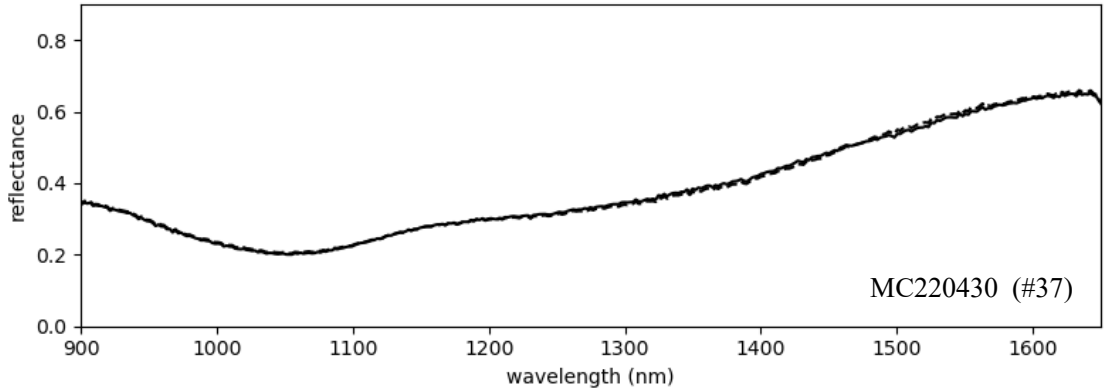
CF211102_dry.csv and CF211102_ice.csv

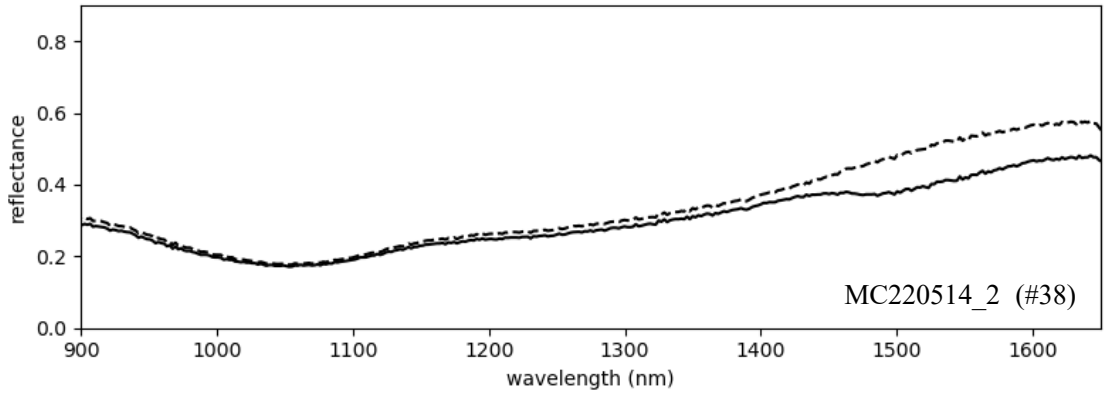
CF211115_dry.csv and CF211115_ice.csv

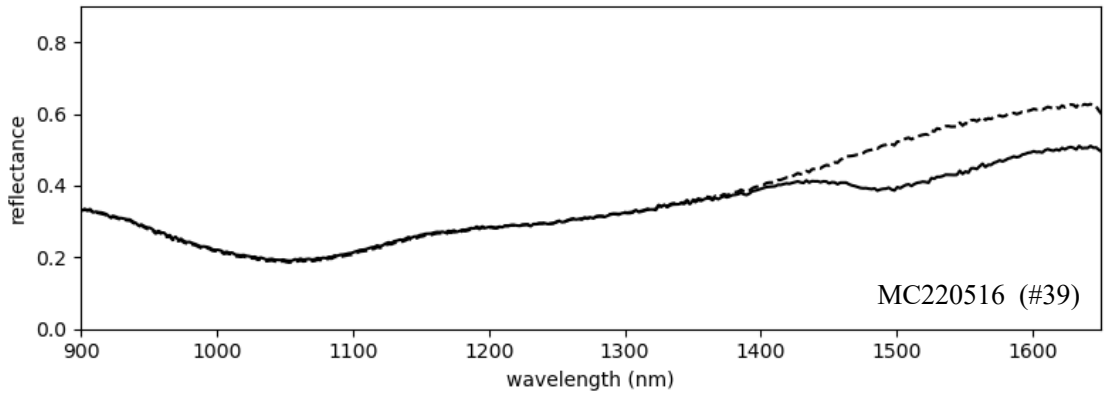
CF211119_dry.csv and CF211119_ice.csv

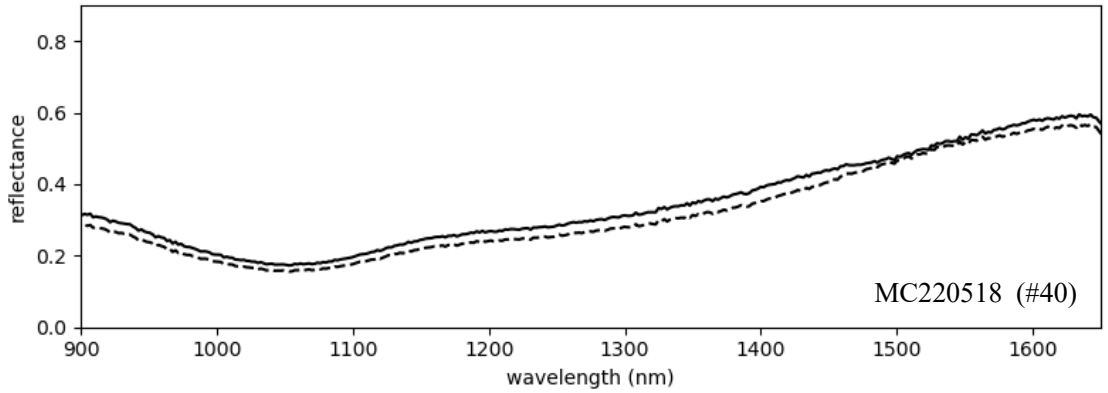
(g) three mineral species mix data (ϕ = 180-250 um)











CSV data list (located in the folder path ‘Experimental Data’ > ‘Mixture’ > ‘180-250um’ > ‘raw data’)

MC220427_dry.csv and MC220427_ice.csv

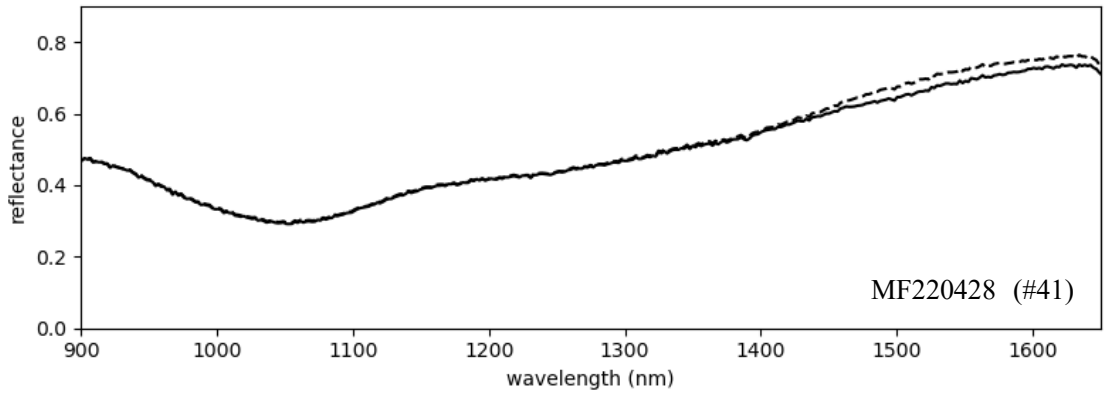
MC220430_dry.csv and MC220430_ice.csv

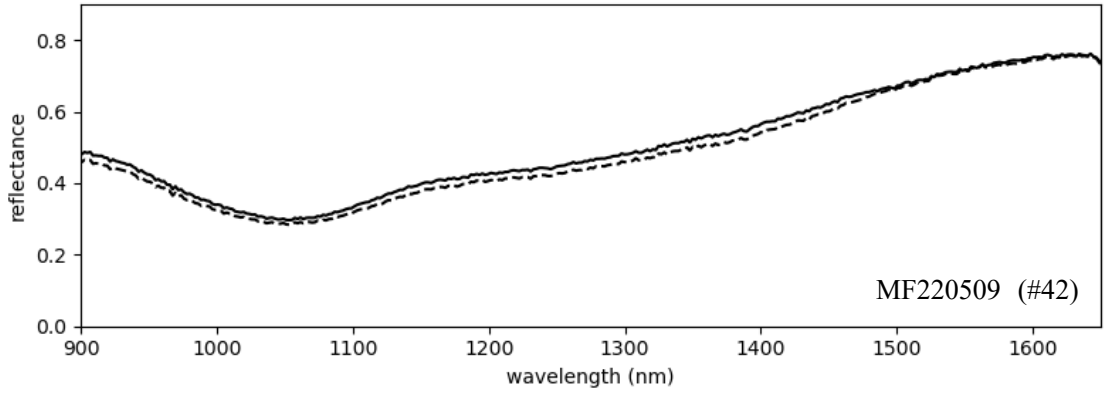
MC220514_2_dry.csv and MC220514_2_ice.csv

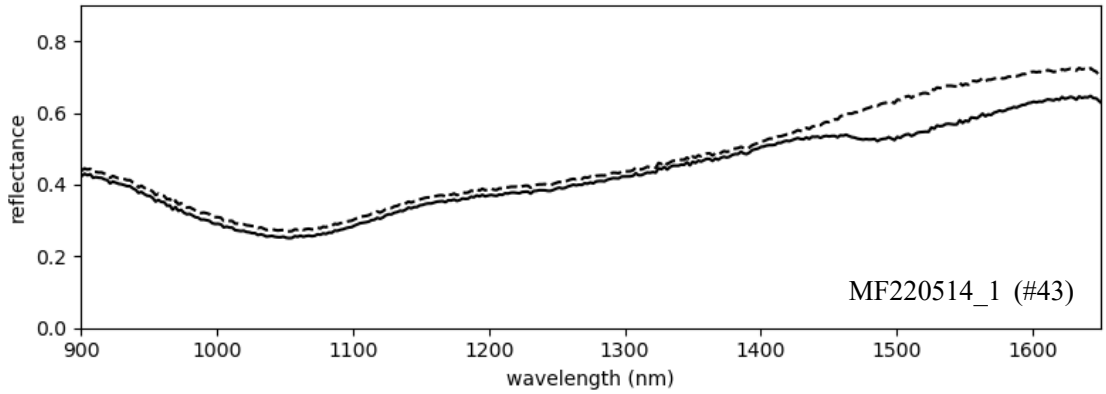
MC220516_dry.csv and MC220516_ice.csv

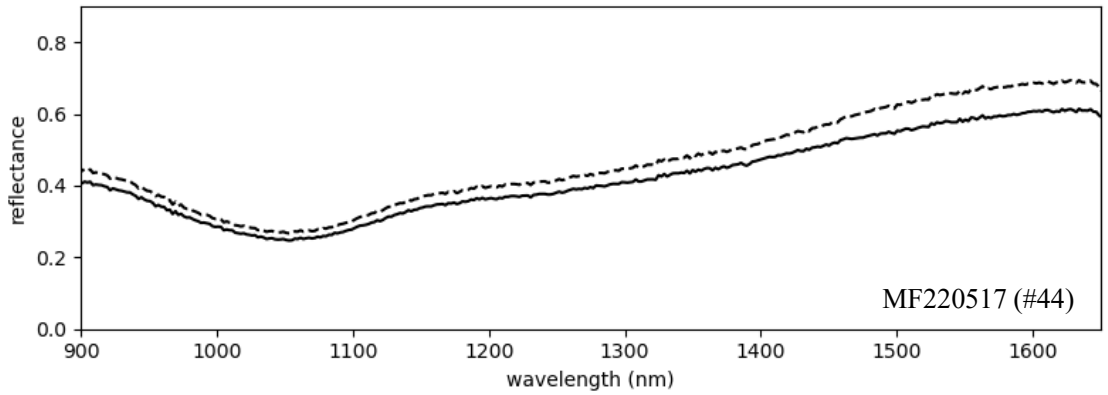
MC220518_dry.csv and MC220518_ice.csv

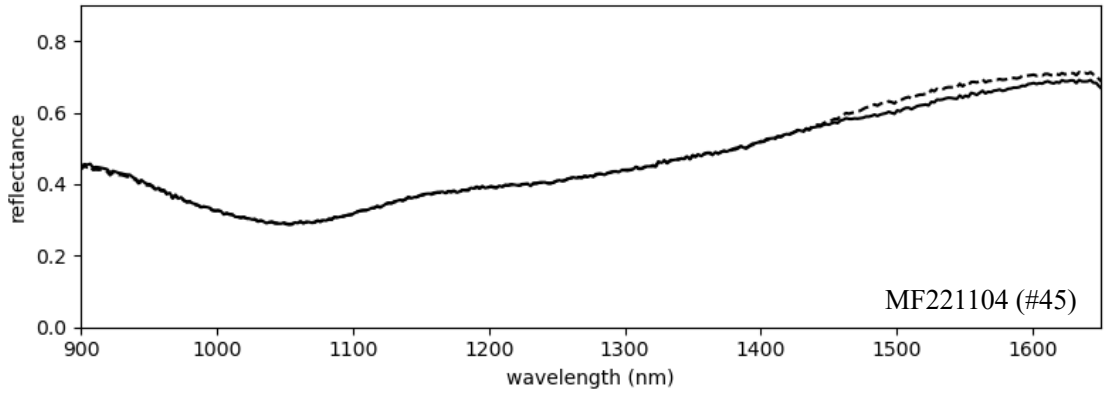
(h) three mineral species mix data (ϕ = 75-125 um)

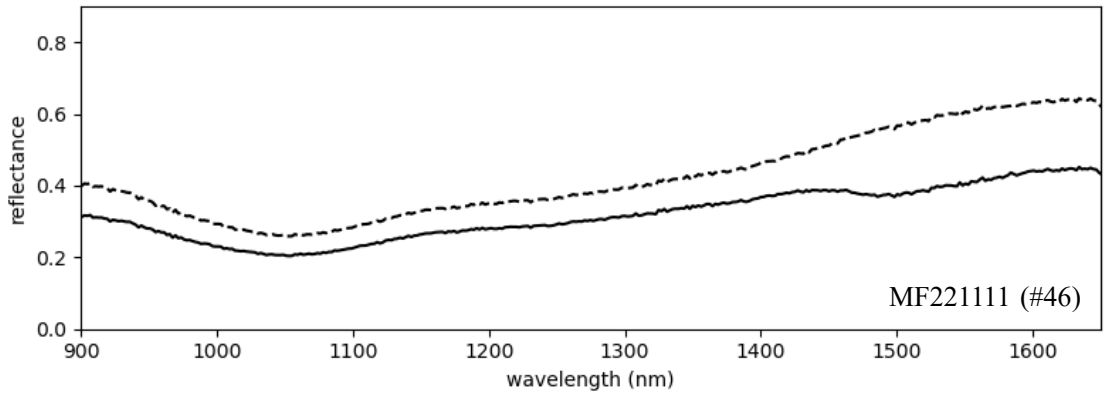












CSV data list (located in the folder path ‘Experimental Data’ > ‘Mixture’ > ’75-125um’ > ‘raw data’)

MF220428_dry.csv and MF220428_ice.csv

MF220509_dry.csv and MF220509_ice.csv

MF220514_1_dry.csv and MF220514_1_ice.csv

MF220517_dry.csv and MF220517_ice.csv

MF221104_dry.csv and MF221104_ice.csv

MF222222_dry.csv and MF222222_ice.csv