Mineralogy and mineral chemistry of a newly identified shock-melted Itokawa particle RB-CV-0082.

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INTRODUCTION:

Most of Itokawa particles have experienced long-term thermal metamorphism and subsequent impacts [e.g., 1-8]. Some of them show evience of strong impact effects with shock-induced melting and vaparization such as RA-QD02-0060, RA-QD02-0048, RA-QD02-0039, and RA-QD02-0070 [9], suggesting that each particle has different impact history. The timing of the catastrophic impact that disrupted the initial parent body and created the rubble pile structure of Itokawa is not yet identified because of lack of data accumulation. Although some important $^{40}Ar/^{39}Ar$ age data were already reported from shocked particles [10-11], those ages most likely provided a *minimum* age of 2.1 Gafor the disruption event [10]. Age dating of a single particle that show evidence of shock melting will most strictly constrain the timing of such intense impact. However, no attempt was made so far. In the present investigation, we plan to fully characterize the mineralogy and shock level of the crystalline phases within the particles using a series of Synchrotron X-ray diffraction, FE-SEM/EBSD and atom probe tomography techniques. This will be followed by $^{40}Ar/^{39}Ar$ analyses of the dust the particles following the approach of [10] where individual particles will be analyze on a single low noise ion-counter of an ARGUS VI new-generation noble gas machine.

RESULTS AND DISCUSSION:

Among AO3 particles allocated to us (PI: F. Jourdan), one particle RB-CV-0082 shows textural and mineralogical evidence of shock melting. It is 100μm-size particle with edged structure. Several sets of crystal plates probably plagioclase are shown on the surface. Synchrotron XRD analysis indicates that it consists of Ca-rich pyroxene, olivine, and plagioclase. The reflections from plagioclase are broad, suggestive of low crystallinity, while those of Ca-rich pyroxene are asymmetric, indicative of strong chemical zoning or heterogeneity. The particle was embedded in epoxy and carefully polished: still more than 2/3 of the particle remains in epoxy for the use of Ar-Ar analysis. FE-SEM/EDS observation of the polished surface indicates that the particle has a quenched melt texture: 5 to 20μm-size crystals of mainly Ca-rich pyroxene with variable kosmochloric component and minor olivine are enclosed in a fine-grained glass rich in Si, Mg, Al, Ca, Na, and K. Glass/crystal ratio is approximately 1 on the polished surface. There are many voids in the particle. The texture indicates that the particle was heated to have melted and quenched at a high cooling rate. K distributes unevenly in the glass up to 2wt%. EBSD and Ar-Ar analysis that will be performed next constrain the shock intensity and timing.

We have carried out mineralogical comparison between heavily shocked Itokawa particles and Y-790964 LL chondrite, The meteorite experienced severe impact and melted to show characteristic mineral chemistry similar to the Itokawa particles [12]. Our direct comparison confirmed the mineralogical similarities between them including a wide range of Ca zoning in pyroxene, indicating that heavily shocked Itokawa particles experienced shock melting similar to Y-790964 LL chondrite. Our study also revealed some mineralogical and compositional differences, which indicates that Itokawa particles were heated to temperature lower than and cooler much faster than Y-790964 LL chondrite.

REFERENCES: [1] Nakamura T. et al. (2011) Science 333, 1113. [2] Yurimoto H. et al. (2011) Science 333, 1116. [3] Ebihara M. et al. (2011) Science 333, 1119. [4] Noguchi T. et al. (2011) Science 333, 1121. [5] Tsuchiyama A. et al. (2011) Science 333, 1125. [6] Nagao K. et al. (2011) Science 333, 1128. [7] Nakamura E. et al. (2012) *Proc. Nat. Acad. Sci*. 109:E624-E629. [8] Mikouchi T. et al. (2014), EPS, 66, 82 [9] Nakamura T. et al. (2014) *HAYABUSA2014*: Symposium of Solar System Materials. [10] Jourdan F. et al. (2015) Goldschmidt Conf.Abstr,1479. [11] Park J. et al. (2015) MAPS 50, 2087.[12] Takeda H. et al (2015) Earth, Planets Space 67, 5.