PETROLOGY AND MINERALOGY OF AN IMPACT MELTED H CHONDRITE, LAP02240. T. Niihara[1], N. Imae[1,2] and H. Kojima[1,2], [1]Department of Polar Science, The Graduate University for Advanced Studies, 1-9-10, Kaga, Itabashi, Tokyo 173-8515, Japan (niihara@nipr.ac.jp), [2]Antarctic Meteorite Research Center, National Institute of Polar Research, 1-9-10, Kaga, Itabashi, Tokyo 173-8515, Japan.

Introduction: Shock metamorphism is one of the most important geological processes in the meteorite parent bodies [1]. Almost all of meteorites have experienced shock metamorphism. Shock metamorphism includes mineral deformation, fracturing, brecciation, degassing, melting and volatilization. Localized shock melting occurs at shock pressures of ~5-10 GPa, and whole-rock melting and formation of impact melt rocks require >75-90 GPa [1]. Impact-melt rocks are commonly observed in ordinary chondrites as clasts in fragmental and regolith breccias but rarely as whole rocks [2-6]. Here we report a petrological and mineralogical study of an impact-melted H chondrite, LAP02240 [9] and mineralogically compared it with Y-791088 in order to obtain detailed information on shock events on its parent body.

Sample and analytical methods: A polished thin section (PTS) of LAP02240, 7 (104 mm^2) was examined by an optical microscope, a JEOL 5900LV scanning electron microscope (SEM), and a JEOL JXA-8200 electron probe microanalyzer.

Results: LAP02240 is an impact melt rock composed of mineral fragments and relict chondrules embedded in a melt matrix. Constituent phases are olivine, pyroxene, Fe-Ni metal, FeS, and feldspathic glass. We found neither feldspar nor chromite. We found opaque veins in the melt matrix (Fig. 1).

Mineral fragments (up to 400 μm in size) are irregularly shaped olivine, pyroxene, and Fe-Ni metal (Fig. 2). Olivine and pyroxene fragments are characterized by dusty features due to the presence of minute metal grains (< 1 μm). These grains are mainly located along healed cracks and planer fractures, causing "shock darkening" [1, 11]. Feldspathic glasses are also located along cracks and planer fractures.

We found two types of relict chondrule; porphyritic olivine (PO) and barred olivine (BO) chondrules (~400 μm in diameter) (Figs. 3 and 4). Many of the relict chondrules show elongated shapes. The porphyritic olivine chondrule consists of olivine, glass, and metals. Olivine grains have inclusion of fine-grained metals and feldspathic glasses mainly located along healed cracks and planer fractures. Barred olivine chondrules consist of olivine bars, and interstitial mesostasis rich in fine-grained pyroxene.

The impact melt matrix shows a microporphyritic texture and consists of fine-grained olivine (~20 μm in size), pyroxene (~30 μm in size), interstitial feldspathic glass, and chromite (~10 μm in size). Fine-grained olivine, pyroxene, and chromite are euhedral or subhedral in shapes.

Fig. 1. Photomicrograph of LAP02240.

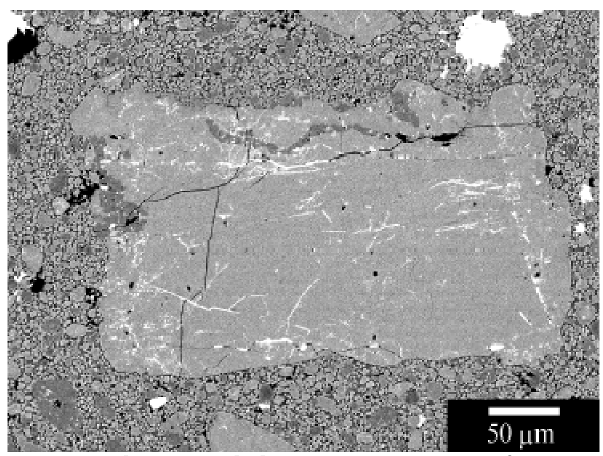

Fig. 2. Back-scattered electron (BSE) image of coarse-grained olivine fragment with fractures filled with Fe-Ni metal.

The compositional ranges of olivine in mineral fragments and relict chondrules are Fa_{18-20} (C.V. = 2.2 %) and Fa_{17-20} (C.V. = 2.9 %), respectively. These compositional ranges are similar to those of equilibrated H chondrites [10]. The compositional range of pyroxene in relict chondrules is $Fs_{14-19}Wo_{0-8}$, also similar to that of equilibrated H chondrites [10].

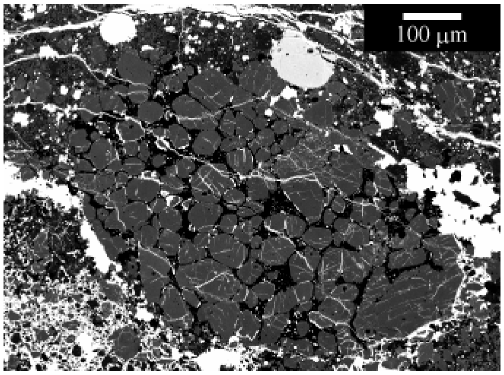

Fig. 3. BSE image of relict PO chondrule.

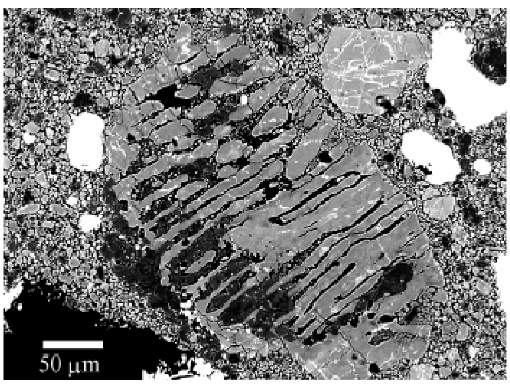

Fig. 4. BSE image of relict BO chondrule.

Discussion: Stöffler et al. [1] proposed that formation of feldspathic glass requires a shock pressure of at least 30 GPa in a solid rock. The presence of fine-grained igneous olivine and pyroxene suggests that LAP02240 melted by impact event(s) and crystallized rapidly from the melt. Solidus temperatures of olivine (Fa_{18-20}) and pyroxene ($Fs_{14-19}Wo_{0-8}$) are ~1650 °C [12] and ~1400-1450 °C [13], respectively. These facts suggest that post-shock equilibrium temperatures of LAP02240 were at least solidus temperature of pyroxene of ~1400-1450 °C but not higher than ~1650°C. Stöffler et al. [1] argued that shock pressures of at least 75-90 GPa (>20-40 GPa, if a precursor was porous) and post-shock temperatures of at least 1500-1750 °C are required for whole rock melting of ordinary chondrites.

Y-791088 is an impact melted H chondrite [8] texturally similar to LAP02240. Y-791088 contain mineral fragments of olivine and pyroxene, relict chondrules set in a fine-grained melt matrix. Chemical compositions of silicates are homogeneous within the range of equilibrated H chondrites. Shock features such as undulatory extinction in olivine, plainer or irregular fractures in silicates, dusty cores in olivine, and feldspathic glass are common features of both meteorites.

However, there are significant differences. Fine-grained igneous plagioclase embedded in feldspathic glass was only recognized in Y-791088. Mineral fragments are more abundant in Y-791088 than those in LAP02240. The grain sizes of olivine fragments in LAP02240 (< 400 μm) are generally smaller than those in Y-791088 (< 1 mm).

Melting degree is apparently greater in LAP02240 than in Y-791088. The presence of igneous plagioaclase indicates that Y-791088 cooled more slowly than LAP02240 did. These impact melt rocks were formed in different locations in impact craters. We suggest that a precursor of LAP02240 was located near the center of a crater where the highest shock pressure was achieved.

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