Microstructural investigations of ureilite meteorite SaU 559

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Sayh Al Uhaymir 559 (SaU 559) is amongst the most reduced meteorites of the ureilite group. SEM, Raman spectroscopy, and EBSD have been used to investigate the deformation recorded by silicates and diamond, and to characterize carbon phases other than diamond.

SaU 559 is dominated by olivine and pyroxene [1]. Olivine crystals are ≤ 1.5 mm in size and pyroxene ≤ 1 mm. Olivine crystallographic preferred orientations (CPO) show strong concentrations on (001) axes (parallel to X), and on (010) axes perpendicular to X. This suggests the activation of the (010)[001] slip system. As observed in olivine, pyroxene CPO show a strong concentration on (001) axes, that probably represents a concordant deformation in both minerals. These results show, for the first time in a ureilite ductile deformation of silicates probably during primitive body differentiation and before shock impact.

SaU shows two carbon-rich interstitial zones. The first zone contains needle-like carbon (up to 10 µm) surrounded by interstitial metal. The absence of crystallographic response with EBSD suggests a poor degree of crystallization for this graphite. The second zone contains diamond crystals (25 µm in size) associated with nanocrystalline graphite surrounded by coarser distorted graphite. Nanocrystalline graphite was identified by multiple Raman spectra (FWHM of the G-peak 34 cm^{-1} to 61 cm^{-1}, G-peak above 1586 cm^{-1}, and D-peak / G-peak heights above >1.5 [2-3]). The mean peak position of diamond (1331.9 ± 0.2 cm^{-1}) is within error of other diamond grains in ureilites. However, their large FWHM (8.4 ± 0.8 cm^{-1}) compared to kimberlite diamond (<5 cm^{-1} [4]) suggests local disorder, which could be associated with a large amount of impurities stemming from a rapid formation. Moreover diamond is weakly deformed (intra-crystalline misorientation up to 5°) and shows weak CPO. All together, these results suggest that diamond has not been deformed by ductile processes or by impact, and probably crystallized during impact processes.

[1] Meteoritical Bulletin, no. 102. [2] Ferrari A.C. and Robertson J. 2000. *Physical Review B* 61:14095-14107. [3] Cançado L.G. et al. 2011. *Nano letters* 11.8:3190-3196. [4] Schermer J.J. et al., 1994. *Proceeding of the 4th European Conference on Diamond.* 3:408-416.