THE GROWTH TWINS IN THE CHELYABINSK METEORITE AS AN INDICATOR THERMAL EFFECTS

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Introduction: The Chelyabinsk LL5 S4 W0 meteorite is ordinary chondrites is represented byf several visually distinguishable structural zones - lithologies. This meteorite substance consists by the light, dark and impact melt lithologies. [1-3]. The presence of such zones indicates that shock events occurred in the history of the parent body, which possibly causing a partial or complete remelting of the host rock. The isotopic studies of theChelyabinsk meteorite result in different agesthat have represented by eight [4] or four [5] impact evens. The simplest interpretation of these zones formation is that all three lithologies were produced together during a single impact event: light lithology fragments were put in shock melt and the dark lithology formed by the interaction between the two [6]. In addition, such a mechanism for the formation of the breccia texture in large fragments of the Chelyabinsk meteorite has been experimentally proven. [7, 8]. Some structural indicators for assessing pressure and temperature in various zones are considered by various authors. [7, 9]. Now, for the first time, we have discovered annealing twins in taenite particles from the Chelyabinsk LL5 meteorite.

Experimental: Eight fragments of the Chelyabinsk meteorite with light lithology were selected for the study from the collection of the Ural Federal University Meteorite Expedition. After cutting, the surface of the samples was prepared by grinding and polishing. A 2% solution of nitric acid in alcohol was used as an etchant. The meteoritic metal microstructure was examined using Zeiss Axiovert 40 MAT inverted microscope and FE-SEM ∑IGMA VP electron microscope with EBSD and EDS units.

Results and Discussion: Most metal grains in the light lithology areas of Chelyabinsk meteorite contain zoned taenite. However, we observed several homogeneous taenite particles with characteristic annealing twins. The content of Ni in such homogeneous taenite particles is 35 - 39 wt.%. The growth twins usually appear as wide bands bounded by parallel lines associated with coherent {111} planes. Sometimes these microscale twins are not connected with grain boundaries. Similar twins are observed in many fcc alloys and also in austenitic steels after prolonged annealing [9]. It has been established that the substance in the zones of the shock melt of the Chelyabinsk meteorite was subjected to shock heating above the melting point of silicates. Dark lithology zones were heated above the melting point of troilite [1, 7], Previously, it was experimentally shown that the cloudy zone in taenite disappears when heated to a temperature of 700 ˚C [11]. Homogenization of taenite with the formation of twins can occur at temperatures above 700 ˚C.

Conclusions: Impact heating above 700 ˚C can lead to homogenization of taenite particles and the formation of annealing twins during long exposure or slow cooling.

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References: [1] Badyukov D. D. et al. (2015) *Petrology* 23:103–115. [2] Galimov, E M et al. (2013) *Geochem. Int.* 51: 522–539. [3] Grokhovsky V. I. et al. (2014) *Meteoritics & Planetary Science* 49: A5364. [4] Righter K. et al. (2015) *Meteoritics & Planetary Science* 50: 1790–1819. [5] Beard S. P. et al. *Meteoritics & Planetary Science* 54 S2: A27. [6] Morlok A. et al. (2017) *Icarus* 284: 431–442. [7] Kohout T. et al. (2020) *Astronomy & Astrophysics* 639: A146. [8] Grokhovsky V. I. et al. (2020) *Planetary & Space Science* 192: 105050. [9] Moreau J. and Schwinger S. (2021) *Physics of the Earth and Planetary Interiors* 310: 106630. [10] Schrader A. and Rose A. (1966) De Ferri Metallographia II. [11] Brusnitsyna E. V. et al. (2020) *AIP Conference Proceedings* 2313.