

HIGH TEMPERATURE THERMAL CONDUCTIVITY OF STONY METEORITES.

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Introduction: Thermal properties are used to help determine the survivability of a meteor as it travels through the atmosphere. Thermal conductivity is needed to determine calculating the ablation rates [1], and thus the thermal ablation is one input for mass loss and energy deposited into the atmosphere from meteor breakup [2]. Combination of ablation and fracturing results in most meteorites losing greater than 80% of their mass during entry [3]. The majority of thermal conductivity measurements have been focused on 300K and below [4], with few at elevated temperatures which are needed to more accurately model atmospheric entry.

Samples and Procedure: Multiple meteorites across ordinary chondrites, carbonaceous chondrites, and howardites-eucrites-diogenites are measured. The comparative cut-bar thermal conductivity method is used on an Unitherm model 2101 thermal conductivity meter. Values are determined at six temperature settings from 300K to 850K. Fused quartz is used as the standard and with the meteorite samples cut into cube shape, corrections for surface area and non-isothermal guarding profile.

Results: For the temperature range studied, all meteorites lowest thermal conductivity is at the lowest measured temperature (fig 1). At this point in profile the lowest value is Chelyabinsk (LL5) at 1.27 ± 0.39 W/m-K at 313K and highest is LAR 06287 (L5) at 3.63 ± 0.18 W/m-K at 317K. Majority of meteorites studied, across all types, have a peak thermal conductivity at 375K, with the rest at 475K. Ordinary chondrites have a wide range at peak thermal conductivity with the low for SAN 03244 (L5) at 2.96 ± 0.12 W/m-K at 384K and the high being LAR 06286 (H6) at 5.91 ± 0.28 W/m-K at 471K. The highest measured temperature has the second lowest thermal conductivity for all meteorites. At the maximum measured temperature, the lowest value is Jbilet Winselwan (CM) at 2.32 ± 0.33 W/m-K at 807K and the highest is NWA 2060 (How) at 4.45 ± 0.45 W/m-K at 813K.

Discussion and Conclusion: All meteorites measured show the same trend of increasing thermal conductivity with increasing temperature until top value between 375K to 475K and then decreasing conductivity with increasing temperature. The initial ~300K measurement and increase is a continuation of what has been seen of the sub 300K thermal conductivity of others work [5]. Similar to the sub 300K conductivities, the high temperature measurements have a complete overlap of all stony meteorite types. The overlap different stony meteorite types and the similar thermal conductivity profiles would suggest that the free metal grains have minimal influence on the thermal conductivity. High porosity can depress conductivity, and this is seen here with all the meteorites with below 10% porosity at the upper bounds of the thermal conductivity range for each temperature step. It can be difficult to fully separate the affects metal content and porosity since the metal-poor meteorites in this study tend to have the higher porosities. However, the complete overlap of thermal conductive profiles of ordinary chondrites they would suggest that porosity plays a greater role than free metal grains.

References: [1] Campbell-Brown M. D. et al. (2013) *Astronomy and Astrophysics*, 557, A41:1-13. [2] Wheeler L. F. et al. (2017) *Icarus*, 295:149-169. [3] Sears D. W. (1974) *Thermoluminescence and Fusion Crust Studies of Meteorites*. University of Leicester. [4] Ostrowski D. and Bryson B. (2019) *Planetary and Space Science*, 165:148-178 [5] Opeil C. P. et al. (2012) *Meteoritics & Planetary Science*, 47:319-329.

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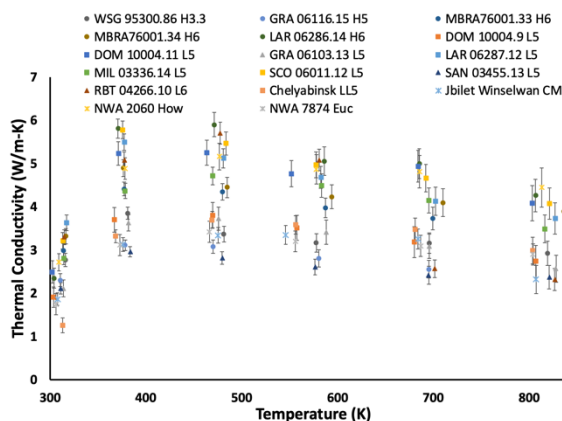


Figure 1: Thermal conductivity profiles for stony meteorites. Ordinary chondrites cover full range of thermal conductivities at each temperature. Howardite and eucrite are at opposite sides of each range for all temperatures. Numbers after period for each Antarctic meteorite is sample number assigned by Johnson Space Center's Astromaterials Sample Control Center.