THERMAL DIFFUSIVITY OF METEORITES.

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Introduction: Determination of thermal properties of meteorites is important for description of evolution of asteroids and planets. Thermal diffusivity of selected meteorites has been studied by a number of researchers [1-6]. The aim of the paper was to determine and analyze thermal diffusivity of various meteorites at room temperature.

Methods: Thermal diffusivity D of meteorites was measured by the Laser Flash Method at ambient conditions, at 298 K in one atmosphere air. Bulk density of the samples was determined by the Archimedean method. Relative errors of measurements of diffusivity are about 1-6 %, and density about 1 %.

Results and discussion: Thermal diffusivity of achondrites is in the range of $(0.4\text{-}2.4)\bullet10^{-6}$ m^2/s, chondrites $(0.5\text{-}2.0)\bullet10^{-6}$ m^2/s, stony-irons $(1.3\text{-}7.0)\bullet10^{-6} m^2/s$, and octahedrites $(7\text{-}19)\bullet10^{-6}$ m^2/s. Exemplary values of D are: NWA 4039 (eucrite, $0.41\bullet10^{-6}$ m^2/s), HaH 286 (eucrite, $0.93\bullet10^{-6}$ m^2/s), Zaklodzie (enstatite achond., $1.04\bullet10^{-6}$ m^2/s), Allende (CV3, $0.56\bullet10^{-6}$ m^2/s), NWA 4967 (CO3.2, $1.00\bullet10^{-6}$ m^2/s), NWA 1609 (H4-6, $1.08\bullet10^{-6}$ m^2/s), El Hammami (H5, $1.57\bullet10^{-6}$ m^2/s), DaG 610 (H4, $1.64\bullet10^{-6}$ m^2/s), Thuathe (H4/5, $2.01\bullet10^{-6}$ m^2/s), NWA869 (L4-6, $1.03\bullet10^{-6}$ m^2/s), Gold Basin (L4, $1.32\bullet10^{-6}$ m^2/s), Vaca Muerta (mesosiderite-A1, $1.34\bullet10^{-6}$ m^2/s), Brahin (pallasite PMG, $(2.1\text{-}6.9)\bullet10^{-6}$ m^2/s), Campo del Cielo (IAB-MG, $15.8\bullet10^{-6} m^2/s$), Odessa (IAB-MG, $12.4\bullet10^{-6} m^2/s$), Morasko (IAB-MG, $(7\text{-}19)\bullet10^{-6}$ m^2/s), Henbury (IIIAB, $10.3\bullet10^{-6}$ m^2/s), and Gibeon (IVA, $7.2\bullet10^{-6}$ m^2/s).

Measurements of twenty meteorites revealed relationship between thermal diffusivity and bulk density of meteorites. Thermal diffusivity is a linear function of bulk density which is expressed by the empirical equation

$$D = A\cdot d + B, \qquad (1)$$

where D is thermal diffusivity (10^{-6} m^2/s), d (kg/m^3) is bulk density of meteorites, and coefficients A and B are constant for a given temperature ($A=2.49\bullet10^{-9} m^5kg^{-1}s^{-1}$, $B= -7.11\bullet10^{-6} m^2/s$ at 298 K). Not only our but also literature data confirm validity of eq. (1). Coefficients A and B depend on temperature and express effect of temperature on thermal diffusivity. Using values of D and d measured for five meteorites (four chondrites and one octahedrite) by Osako [6] enabled us to determine A and B values for various temperatures:

$A = 2.37\bullet10^{-9} m^5kg^{-1}s^{-1}$, $B = -6.19\bullet10^{-6} m^2/s$ at 100 K,
$A = 2.11\bullet10^{-9} m^5kg^{-1}s^{-1}$, $B = -6.24\bullet10^{-6} m^2/s$ at 200 K,
$A = 2.10\bullet10^{-9} m^5kg^{-1}s^{-1}$, $B = -6.52\bullet10^{-6} m^2/s$ at 300 K.

Conclusions: Relationship between thermal diffusivity and bulk density of meteorites has been established that can be applied for evaluation of thermal diffusivities of extraterrestrial matter at various temperatures.

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