MEAN ATOMIC HEAT OF SARIÇIÇEK HOWARDITE AND BURSA L6 CHONDRITE. M. A. Szurgot[1], R. A. Wach[2], C. Altunayar-Unsalan[3] and O. Unsalan[4], [1]Lodz University of Technology, Center of Mathematics and Physics, Al. Politechniki 11, 90 924 Lodz, Poland (mszurgot@p.lodz.pl), [2]Lodz University of Technology, Institute of Applied Radiation Chemistry, Wróblewskiego 15, 93-590 Lodz, Poland (wach@mitr.p.lodz.pl), [3]Ege University, Central Research Testing and Analysis Laboratory Research and Application Center, 35100, Bornova, Izmir, Turkey (cisemaltunayar@gmail.com), [4]Ege University, Faculty of Science, Department of Physics, 35100, Bornova, Izmir, Turkey (physicistozan@gmail.com).

Introduction: Thermophysical properties and mean atomic weight are important to characterize minerals, rocks, planets, moons and asteroids, and are important to classify meteorites. Recently room temperature values of mean atomic heat *(Catom)* of Jezersko H4 chondrite and some other ordinary chondrites, and Sariçiçek howardite have been predicted [1-3]. The aim of the paper was to determine and analyse mean atomic heat of Bursa L6 chondrite and Sariçiçek howardite at various temperatures. Both meteorites fell in Turkey. Sariçiçek meteorite fell on September 2, 2015, and have been classified as an eucrite-rich howardite [4, 5], and Bursa meteorite fell in 1946, and have been classified as a L6 chondrite [6, 7].

Methods: Mean atomic heat *(Catom)* at various temperatures was calculated by the equation:

$$Catom(J/(mol \cdot K)) = Amean(g/mol) \cdot Cp(J/(kg \cdot K)). \qquad (1)$$

Since both properties*: Amean* and *Cp* are important for characterization of terrestrial and extraterrestrial matter, their product is expected to be very useful property, as well.

Literature data on bulk composition were used to calculate mean atomic weight *(Amean)* of these meteorites [4, 8]. Specific heat capacity *Cp* of crushed samples (c.a. 20 mg) of Bursa interior samples, and Sariçiçek interior, edge, and crust samples were determined by a DSC Q200 (TA Instruments, USA) in the temperature range between 223 and 623 K [3, 9].

Results and discussion: Figure 1 presents temperature dependence of Sariçiçek interior, edge, and crust matter, and figure 2 *Catom(T)* dependence for Bursa interior matter.

The best fit for *Catom(T)* data is expressed by the equation:

$$Catom(T)(J/(mol \cdot K) = A \cdot \exp(-C \cdot T) + B, \qquad (2)$$

where T is an absolute temperature (K), and A, B, and C are constants.

Values of constants A, C, and B for Bursa interior, Sariçiçek interior, Sariçiçek edge and Sariçiçek edge crust are collected in table 1.

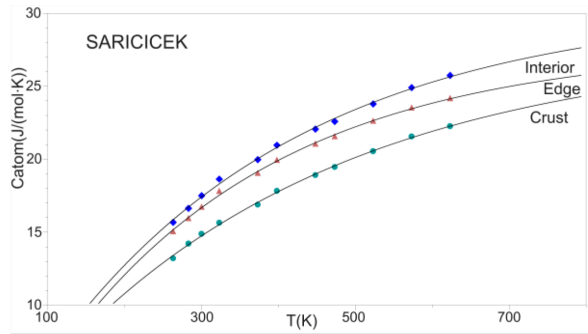

Fig. 1. Temperature dependence of mean atomic heat of Sariçiçek interior, edge and crust matter. Mean atomic weight of Sariçiçek howardite: *Amean* = 22.46 g/mol.

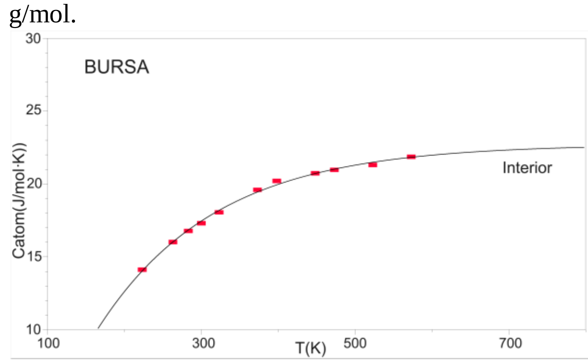

Fig. 2. Temperature dependence of mean atomic heat of Bursa interior matter. Mean atomic weight of Bursa chondrite: *Amean* = 23.41 g/mol.

Table 1. Values of constants A, C, and B of equation (2) for Bursa and Sariçiçek meteorites.

Meteorite	*A*	*C*	*B*	RMSE*
BURSA interior	-37.14	0.00652	22.72	0.15
SARIÇIÇEK interior	-32.4	0.00304	30.56	0.18
edge	-31.40	0.00348	27.72	0.15
crust	-28.90	0.00264	27.86	0.13

*Root mean square error.

Values of mean atomic heat *Catom(J/(mol ·K))* for Bursa and Sariçiçek meteorites at 200 K, 300 K and

623 K predicted by equation (2) are collected in table 2.

Table 2. Values of mean atomic heat *Catom(J/(mol·K))* predicted by equation (2) for Bursa and Sariçiçek meteorites at 200 K, 300 K, and 623 K.

Meteorite	200 K	300 K	623 K
BURSA interior	12.64	**17.47**	25.63
SARIÇIÇEK interior	12.74	**17.41**	24.13
edge	12.06	**16.67**	22.28
crust	10.82	**14.77**	22.08

The results presented in figures 1 and 2, and in table 2 reveal that values of *Catom* for Bursa interior and Sariçiçek interior are close to each other: 12.64 *J/(mol·K)* and 12.74 *J/(mol·K)* at 200 K, and 17.47 *J/(mol·K)* and 17.41 *J/(mol·K)* at 300 K. Room temperature values of mean atomic heat of both meteorites are very close to the mean value of *Catom* established by Szurgot for ordinary chondrites: 17.5±0.6 *J/(mol·K)* at 300 K [1], and are close the *Catom (300 K)* value predicted for Jezersko H4 chondrite: 17.4±0.4 *J/(mol·K)* [1].

In the case of Sariçiçek howardite matter the following inequalities are valid for *Catom* values:

Crust(10.82) < Edge(12.06) < Interior(12.74), (3)
for 200 K,

Crust (14.77) < Edge(16,67) < Interior(17.41), (4)
for 300 K, and

Crust (22.08) < Edge(22.28) < Interior(24.13), (5)
for 623 K.

The crust matter exhibits about 9-18% lower value of *Catom* than interior matter, and an edge matter, adjacent to the crust border, about 4--8% lower value of *Catom* than interior matter.

It was assumed in our calculations that *Amean* values of interior, edge, and crust matter are the same:

Amean((Interior) = Amean(Edge) = Amean(Crust). (6)

Equality:

Amean((Interior) = Amean(Edge), (7)

seems to be correct, but *Amean* of crust can be somewhat different, probably lower than atomic weight of interior and of edge matter. So, we expect that:

Amean((Interior) = Amean(Edge) ≥ Amean(Crust), (8)

rather than equation (6) is more real. Expected small differences in *Amean* values of crust and interior/edge matter should not affect significantly the mean atomic heat of crust.

Using equation (1) one can predict value of mean atomic heat of any meteorite, at any temperature for which *Cp*, and *Amean* values are known. Substituting *Amean* = 23.61 g/mol, and *Cp* = 722±22 J/(kg·K) predicted for Çanakkale L6 chondrite at 300 K [10] in equation (1) gives for Çanakkale chondrite interior *Catom(300 K)* = 17.05±0.51 *J/(mol·K)*. This is a reliable value for this chondrite, but lower than *Catom(300 K)* values established for Bursa chondrite and Sariçiçek howardite (Table 2).

Conclusions: Mean atomic heat of Bursa chondrite and of Sariçiçek howardite are close to each other at 200 K and 300 K, and are comparable with atomic heats of other ordinary chondrites at room temperature. Temperature dependence of mean atomic heat *Catom(T)* for interior, edge and crust of Sariçiçek howardite and Bursa chondrite interior is expressed by the same, natural exponential function. Crust matter exhibits the lowest mean atomic heat, interior matter the highest atomic heat, end edge matter intermediate atomic heat. Specific heat capacity is responsible for temperature changes of mean atomic heat and for differences in *Catom* values observed for interior, edge, and crust matter. Mean atomic heat is, similarly as specific heat, sensitive to noncrystalline material, dominant in crust and abundant in edge matter, and sensitive to crystalline material, dominant in interior matter. It is expected that mean atomic heat of Vestan regolithe is properly represented by mean atomic heat of Sariçiçek howardite.

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