# EXPERIMENTAL MODELLING OF THE FUSION CRUST FORMATION BY HEATING IN PLASMATRON

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**Introduction:** The physical ability of the Earth's atmosphere to protect the surface from the meteoroids depends on the entrance angle and the speed of the meteoroid, while the efficiency of the meteoroid destruction is mostly established by the mechanical properties of the meteoroid itself. Therefore, it is interesting to understand deeply how the atmosphere melts the meteoroid's surface; how to estimate the influence of the heating duration on the structure degradation; how meteorites of different types resist to the interaction with the atmosphere.

Physical theory of meteors falls and heat transfer into meteoroid material was developed previously in [1], where the authors compared the laboratory experiment with the Earth's atmosphere properties and tried to reproduce the fall of the meteoroid. Different types of meteorites have different fusion crust. For example, lunar meteorite and eucrite fusion crust variability were described in [2]. An experimental modeling of the fusion crust formation with materials of different types was performed in the present experiment using plasmatron. Due to the fact that most of the meteoroids are the parts of the Near Earth Asteroids of S-class, which are associated with the ordinary chondrites [3], two chondrite samples were taken for the study.

**Samples and Methods:** Few model materials were chosen for the high-temperature heating in the plasmatron with the high-speed flow of argon atmosphere. By this experiment, it is possible to study the ablation process of the meteoroid as it has been fallen on the Earth surface. The specimens for the study were model material: samples of steel, gabbro, granite, granular limestone, and two samples of Chelyabinsk LL5 and Tsarev L5 stony meteorites.

All the samples were prepared in the shape of bars 5 x 5 x 50 mm, 3 specimens each of the type. Their initial texture was studied under the optical microscope Carl Zeiss AxioVert 40 MAT and electron microscope Carl Zeiss ΣIGMA VP with the X-MAX EDS option. The heating experiment was performed at the temperature up to 2000°C using the plasmatron with de Laval nozzle, 5 A current and 50 kPa pressure. Equipment specification was described in [4]. Moreover, the plasmatron is equipped with a high-frequency video camera for recording of the experiments, and an optical pyrometer for the temperature control. Every sample was heated in plasmatron until the melting point. The samples were weighed before and after the experiment for the evaluation of the mass lost. Polished sections of the samples were prepared using diamond pastes for the optical microscopy, therewith they were carbon coated for the EDS study.

**Experimental:** The aim of the study is to partly reproduce a shock heating of the meteoroid's surface during the fall through the atmosphere. This process includes the fusion crust formation and ablation of the surface material within the gas flow. At the same time, the experiment allows to analyze the products of the process, while they are forming. Special plasmatron cover was developed for catching of the ablation spherules and melted drops for their further analysis.

Duration of the heating varied, depending on the type of the model material: steel sample was melted in 6 sec., while all other samples were heated around 30 sec. to obtain the melt on the sample surface. The fusion crust was formed in each experiment. It should be noted, in the case of steel, the melt was abundant and it flew away fast, that is why this sample lost ~18 % of its initial mass. The Chelyabinsk LL5 sample was the second one by the amount of the mass loss following by Tsarev L5, then granite, granular limestone, and gabbro sample.

Texture observation of the newly formed fusion crust in comparison with the original samples texture was performed. Few similar features were revealed in fusion crust of granular limestone, granite, gabbro, Chelyabinsk LL5 and Tsarev L5 samples. However, fusion crust thickness, quantity, and viscosity varied. Such texture features as vesicles, eutectic and glass were found in all the samples except steel. It is indicative that steel sample has a smooth fusion crust, which is relatively thick in section and it has a band of non-metallic inclusions between the crust and unchanged material. On the example of Chelyabinsk meteorite, we could compare structure obtained from the experiment with the 'naturally' formed fusion crust. It appears to have similar texture and composition.

**Conclusions:** It is possible to partly reproduce the ablation process of the meteoroids in the atmosphere by the experimental heating in plasmatron. Fusion crust was obtained for each sample, while its texture was different. It was shown that the resistance to melting and mass losing efficiency corresponds to the samples material properties.

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