HIGH-SPEED VISUALIZATION OF COMBUSTION SYNTHESIS DISCRETE REACTION WAVES: COHERENT HEAT MICROSTRUCTURES[1]

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The paper shows new possibilities for studying the effects of microheterogeneous combustion by the method of high-speed micro-thermal imaging. On each video frame, the area of the microfocal reaction has been identified, where local superadiabatic heating takes place. All the discrete regions of heat generation were combined on a common image of the thermal microstructure of the combustion reaction wave. The characteristic size of the foci of combustion in the Ni-Al system was from 150 to 300 μm, which is 5 times larger than the size of the largest powder particles. It was found experimentally that the combustion front propagates only in the local regions of superadiabatic heating and the motion has a discrete step. The thermal microstructure has the form of a quasiperiodic sequence of layers, the spatial direction of which weakly depends on the position of the combustion front with respect to the horizontal. To verify this fact, which contradicts the classical theory of wave stability in the spin combustion mode, the differential chronoscopic analysis of the interframe difference in the motion of the combustion front line was selected. As a result, it was shown that, independently of the geometry of the combustion front, a synchronous and quasi-periodic occurrence of new local combustion sites is observed. The period of thermochemical induction between each discrete step of motion was 0.1 to 0.2 ms.

Thus, the data of the 2D thermal map of differential chronoscopy (DCS) allow visualization of the SHS combustion wave in the form of coherent thermal structures with quasiperiodic parameters. At the end of the paper, an example is given of processing a 2D DCS map using Fourier and Trace-transforms to extract statistical indicators of unstable combustion conditions.

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