Combined action of shock wave heating and laser photolysis on methane-oxygen mixture

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Reactions of atomic oxygen with hydrocarbons play a key role in the initial stages of their interaction and are of great importance in combustion processes. Methane, as the main component of natural gas and the most common hydrocarbon in the atmosphere, is one of the main representatives of this series. Most experimental data on direct measurements of the constant of the reaction of methane with an oxygen atom were obtained at the end of the last century. Only with the help of measurements of atomic resonance absorption spectroscopy (ARAS) in shock waves with extremely low initial concentrations of methane was it possible to isolate the very first stages of the reaction of thermal decomposition of CH_4. The use of laser photolysis in combination with highly sensitive ARAS technology helped to exclude, in principle, speculative analysis of side reactions. In this work the time profiles of the O atom concentration were measured by resonance absorption at a wavelength of 130.5 nm. The kinetics of interaction of oxygen atoms with methane at temperatures of 700–1900 K were studied at the experimental complex "Nefrit" created at the JIHT RAS under the combined effect of shock-wave heating and laser photolysis on a gas mixture of 1000 ppm O_2 + 20 ppm CH_4 in argon. Precise experimental data on the rate constant of the reaction of methane with oxygen atoms were obtained and comparted with the previous studies. Using modern kinetic models of methane combustion, numerical modeling of the formation and consumption of atomic oxygen under the corresponding experimental conditions was carried out.