Microparticle energy balance in gas discharge plasma and reactive gas mixtures

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A model of the energy balance of a microparticle (MP) located in a plasma of an electric discharge or reactive gas mixture, is proposed. It considers MP heating as a result of collisions with electrons and ions, recombination and quenching of metastable atoms on its surface (in a plasma), or recombination of radicals (in a reacting gas). Under the typical conditions of dusty plasma experiments in neon, it was found that the contribution of quenching of metastable neon atoms to the MP heating increases with pressure and can amount to up to 40% of the heating associated with electron-ion recombination [1]. The heating of an impurity MP in a reacting mixture of hydrogen–oxygen–argon or propane–oxygen–argon, and the possible acceleration of ignition from such point source, were estimated under the conditions studied in experiments with shock tubes and rapid compression machines. Depending on size of MP and concentration of radicals, the recombination heating of MP in the early stages of combustion was from tens to hundreds of degrees [2]. This can lead to an acceleration of ignition by several times, explain it's temperature dependence, and eliminate the discrepancy between the experimentally observed ignition delays, and those calculated using detailed kinetic mechanisms discussed, e.g., in [3].

[1] Shumova V V, Polyakov D N and Vasilyak L M 2022 *Russ. J. Phys. Chem. B* **16** 912–916
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[3] Vlasov P A, Smirnov V N and Tereza A M 2016 *Russ. J. Phys. Chem. B* **10** 456–468