Soot formation during ethylene pyrolysis with biofuels

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The study of alternative fuels (e.g. biofuels) is an urgent task both from the limited fossil fuels and environmental problems associated with harmful emissions into the atmosphere. Currently, various oxygen-containing biofuels are widely studied. Its production has a «zero carbon footprint», and the oxygen presence in composition should lead to an increase in the oxidation processes efficiency, which in turn could reduce the amount of polycyclic aromatic hydrocarbons (PAHs) and soot nanoparticles formed due to incomplete fuel combustion.

PAHs are mainly formed from incomplete combustion processes and generally considered as precursors for soot particles [1]. The linear and cyclic esters: furan C_4H_4O (F), tetrahydrofuran C_4H_8O (THF), diethyl ether $C_4H_{10}O$ (DEE), dimethoxymethane $C_3H_8O_2$ (DMM)) and alcohols: methanol CH_3OH (M) and butanol C_4H_9OH (B) are of high-potential biofuels representatives [2, 3]. Therefore, it is of particular interest to study their effect on the PAHs and soot formation due to their composition and structure.

At the investigation, experimental study of the effect of listed biofuel additives on the PAHs and soot formation processes during ethylene C_2H_4 pyrolysis diluted in Ar behind reflected shock waves range was carried out. Laser induced fluorescence (LIF) was used to detect polycyclic aromatic hydrocarbons formed during pyrolysis. To induce PAH fluorescence, a Nd:YAG laser at wavelength of 266 nm was used. Besides that laser extinction at 633 nm was used to control the condensed phase appearance and measure its volume fraction. Soot-particle size was determined *in situ* by laser induced incandescence (LII) method using a Nd:YAG laser at a wavelength of 1064 nm and *ex situ* by transmission electrons microscopy (TEM) analysis.

The obtained temperature dependences of carbon nanoparticles sizes and volume fraction in the ethylene mixture have had a well-known «bell» shape [4] with the maximum in the range T_5=2200-2250 K. It was also found that M and B slightly increase soot formation and particle sizes at T_5 = 2000-2200 K; F greatly increases soot formation and particle sizes and expanded the temperature range of its formation; THF also increases soot formation and particle sizes at T_5 = 2240 – 2510 K. The DEE addition results a shift in the soot formation processes to higher temperatures relative to ethylene mixture and slightly increase soot volume fraction and DMM has no any effect on soot formed but increases the soot particle sizes at T_5=2200-2300 K.

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References

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