

# SOOT FORMATION DURING PYROLYSIS OF ETHYLENE WITH ADDITIONS OF METHANOL AND BUTANOL

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**Abstract:** Soot formation during pyrolysis of ethylene with the addition of alcohols (methanol and butanol) behind shock waves in the temperature range 2009–2524 K and pressure 2.56–3.58 bar has been investigated experimentally. Temperature dependences of optical density were measured by laser extinction at a wavelength of 633 nm and the size of carbon nanoparticles was measured by laser-induced incandescence. Temperature dependences of the induction times for the condensed phase appearance were also obtained. It has been shown that addition of methanol and butanol accelerates and increases the soot yield. The observed promoting effect on soot formation is stronger with the addition of butanol than methanol. The kinetic reasons for the influence of methanol and butanol on ethylene pyrolysis are discussed.

**Keywords:** soot formation; carbon nanoparticles; shock tube; ethylene pyrolysis; methanol; butanol

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## Figure Captions

**Figure 1** Time histories of extinction signal for 5% C<sub>2</sub>H<sub>4</sub> + 1% C<sub>4</sub>H<sub>9</sub>OH + 94% Ar mixture, T<sub>5</sub> = 2146 K, and P<sub>5</sub> = 3.11 bar and the procedure of determining the induction time

**Figure 2** Temperature dependences of the optical density measured at reaction times 0.75 (a) and 1.5 ms (b) in ethylene and ethylene–methanol mixtures: 1 – 5% C<sub>2</sub>H<sub>4</sub> in Ar; 2 – 5% C<sub>2</sub>H<sub>4</sub> + 0.5% CH<sub>3</sub>OH in Ar; and 3 – 5% C<sub>2</sub>H<sub>4</sub> + 1% CH<sub>3</sub>OH in Ar

**Figure 3** Temperature dependences of the optical density measured at reaction times 0.75 (a) and 1.5 ms (b) in ethylene and ethylene–butanol mixtures: 1 – 5% C<sub>2</sub>H<sub>4</sub> in Ar; 2 – 5% C<sub>2</sub>H<sub>4</sub> + 0.5% C<sub>4</sub>H<sub>9</sub>OH in Ar; and 3 – 5% C<sub>2</sub>H<sub>4</sub> + 1% C<sub>4</sub>H<sub>9</sub>OH in Ar

**Figure 4** Temperature dependences of soot nanoparticle sizes measured at reaction time 1.5 ms in ethylene, ethylene–methanol (a), and ethylene–butanol (b) mixtures: 1 – PEM 5% C<sub>2</sub>H<sub>4</sub> in Ar; 2 – 5% C<sub>2</sub>H<sub>4</sub> in Ar; 3 – 5% C<sub>2</sub>H<sub>4</sub> + 0.5% CH<sub>3</sub>OH in Ar; 4 – 5% C<sub>2</sub>H<sub>4</sub> + 1% CH<sub>3</sub>OH in Ar; 5 – 5% C<sub>2</sub>H<sub>4</sub> + 0.5% C<sub>4</sub>H<sub>9</sub>OH in Ar; and 6 – 5% C<sub>2</sub>H<sub>4</sub> + 1% C<sub>4</sub>H<sub>9</sub>OH in Ar

**Figure 5** Temperature dependences of induction times of condensed phase appearance in ethylene, ethylene–methanol (a), and ethylene–butanol (b) mixtures. Signs – experimental results and curves – approximations: 1 – 5% C<sub>2</sub>H<sub>4</sub> in Ar; 2 – 5% C<sub>2</sub>H<sub>4</sub> + 0.5% CH<sub>3</sub>OH in Ar; 3 – 5% C<sub>2</sub>H<sub>4</sub> + 1% CH<sub>3</sub>OH in Ar; 4 – 5% C<sub>2</sub>H<sub>4</sub> + 0.5% C<sub>4</sub>H<sub>9</sub>OH in Ar; and 5 – 5% C<sub>2</sub>H<sub>4</sub> + 1% C<sub>4</sub>H<sub>9</sub>OH in Ar

## Table Caption

Experimental conditions

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