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ELECTRICAL DISCHARGE IN HONEYCOMB MONOLITH

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1. INTRODUCTION

Honeycomb catalysts are used in cars for the exhaust gas removal. Their performance depends on gas composition and temperature and can be improved by a combination with plasma. Generation of homogenous and stable plasma inside thin channels of honeycomb catalysts is, however, rather difficult. The paper presents a novel method of setting up stable discharge plasma inside thin channels utilizing a *sliding discharge*. The sliding discharge is a discharge generated on dielectrics by combination of AC and DC powers in three-electrode geometry. The discharge can be generated either on flat dielectric surfaces [1, 2], or along the inner surface of the glass capillaries [3]. The basic characteristics of the sliding discharge inside the capillary channels, addressing the effects of the length of the capillaries and the applied voltage, are presented.

2. EXPERIMENTAL SETUP

Discharge reactor with relevant measuring systems is depicted on Fig. 1. The reactor consisted of a quartz tube (∅ 26 mm) with a bundle of quartz capillaries (∅ 2 mm, lengths 2 and 3 cm) placed on the top of Al_2O_3 pellet bed and packed inside the tube. The capillaries were used instead of honeycomb monolith in order to visually observe the discharges inside the channels. The set of electrodes consisted of a rod plugged in the middle of the bed, Al foil wrapped around the quartz tube and a mesh electrode placed on the top of the capillaries. The rod was powered by AC (50 Hz), the mesh by negative DC high voltage, and the foil was grounded. Negative DC was chosen to ensure discharge operation up to higher voltages without sparking. The pellet bed discharge power was evaluated from Lissajous figures and the power of the discharge in capillaries as a product of DC voltage and a mean current. Optical measurements were performed by an emission spectrometer and the images were recorded by a digital camera.

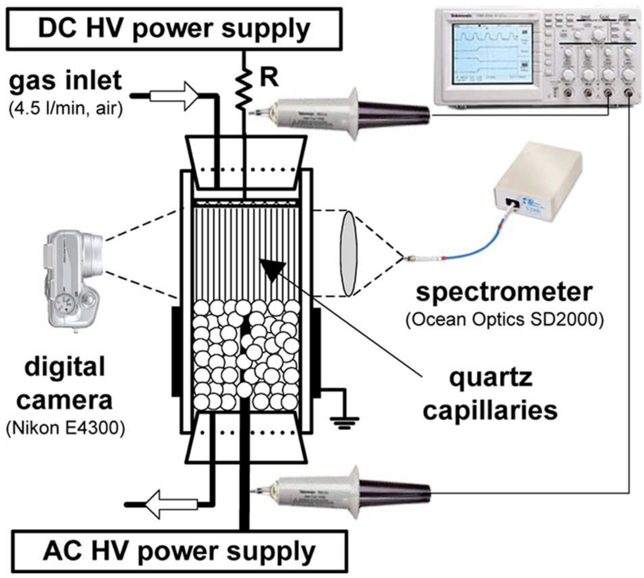

FIGURE 1: Experimental setup.

3. RESULTS AND DISCUSSION

The sliding discharge inside the bundle of capillaries was generated with the assistance of the pellet bed discharge. AC driven pellet bed discharge formed the plasma, which upon the application of negative DC voltage across the capillaries produced streamer development inside them. As a result, stable and homogenous plasma was produced inside the channels.

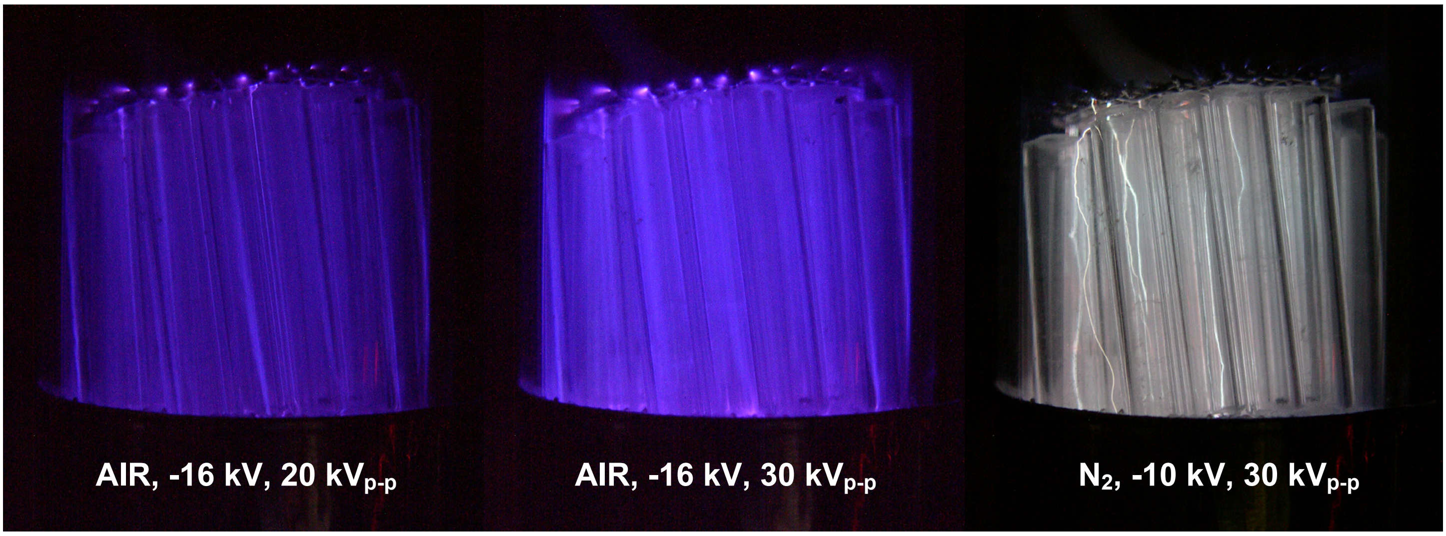

FIGURE 2: Images of sliding discharge in quartz capillaries [capillary diameter 2 mm, length 20 mm, camera settings: ISO 400, f/2.8, ½ s].

Fig. 2 shows images of sliding discharges at various AC and DC voltages. If only AC or DC voltage was applied, the packed bed discharge or the corona discharge at the edges of the mesh electrode was observed, respectively. The sliding discharge inside the capillaries occurred only when both DC and AC were applied. The images also show that the distribution of the discharges and the emission inside the whole capillary were relatively homogenous. At high amplitudes of the DC applied voltage, sparking occasionally occurred (the last image in Fig.2). The discharge power increased with both DC and AC applied voltages, but the effect of AC voltage was negligible. Discharge power decreased with extending the length of capillaries (at a given DC voltage), while diameter of the capillary had only marginal effect. Emission intensity of the sliding discharge increased with both DC and AC applied voltages. The result also showed that to minimize the power consumption but keep the same concentration of active species, it seems appropriate to maximize AC and minimize DC applied voltage. The typical measured temperatures were T_R = 300±30 K, T_V = 1800±300 K. T_R was found independent of the applied voltages.

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