2D LIF diagnostics of a diamond depositing oxyacetylene flame

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2D LIF DIAGNOSTICS OF A DIAMOND DEPOSITING OXYACETYLENE FLAME
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Introduction
Two-dimensional Laser Induced Fluorescence is used to determine molecular distributions in an oxyacetylene flame, used to deposit diamond on a molybdenum or natural diamond substrate. Possible growth species investigated thus far include C$_2$ [1], CH and OH.

Experiment
A commercially available welding torch (orifice 1.6 mm ø) is mounted on a translation stage above a substrate holder, see figure 1. High purity oxygen and acetylene are used, where the flows and mixing ratio are controlled by mass flow controllers. A molybdenum substrate is positioned at 1 mm below the tip of the flame front. The substrate is cooled to 1000°C by a pulsed water vaporizer. Diamond is deposited in a slightly fuel rich flame [2], with growth rates up to 100 μm per hour.

![Figure 1: Experimental setup for LIF measurements in the diamond depositing flame](image)

The output of a Nd:YAG pumped dye laser is used at different wavelengths to detect several molecular species in the flame. The laser beam is focused in the flame by means of two cylindrical lenses, resulting in a thin laser sheet. The fluorescence is collected at right angles with the laser beam, using a CCD camera equipped with an image intensifier. Emission of the flame itself is suppressed by gating the image intensifier. Image processing
hardware and software are used to allow for background subtraction. A spatial resolution of 20 µm is obtained.

In order to avoid saturation of the camera system, molecular distributions have to be measured off-resonant. C\textsubscript{2} is excited at 438 nm and detected at 471 nm (Swan system) and OH is excited at 282 nm and detected at 308-312 nm or excited at 248 nm and detected at 298 nm (A-X). CH is excited at 393 nm (B-X) and detected at 431 nm (A-X), where the A state is populated via collisional relaxation from the B state.

Figure 2: CH LIF distribution in the flame while diamond is being deposited. The flame is reflected in the substrate holder.

All measurements are carried out while diamond is being deposited on the substrate. The distribution of CH is shown in figure 2. Special attention is given to the observed boundary layer (about 0.1 mm thick) just above the substrate. The dependence of the boundary layer on deposition temperature and distance to the flame front is investigated and will be discussed, as well as the quality and morphology of the grown diamond in relation to the molecular distributions in the boundary layer.

References