Determining the velocity field of confined and rarefied gas flows by using molecular tagging velocimetry measurements

Project description

Gas flow behavior is crucial for the performance of various devices, especially in miniaturized systems like space and micro-electro-mechanical systems. Traditional techniques for flow visualization are unsuitable, leading to the development of Molecular Tagging Velocimetry (MTV), particularly for rarefied gas flows.

The Molecular Tagging Velocimetry (MTV) technique works on the laser-induced fluorescence and phosphorescence principle (Figure 1): the displacement of the vapor molecular tracer is measured by following the photon re-emission in the visible spectrum after laser excitation. Very few works have reported MTV diagnostics for internal gaseous flow on the microscale, especially at the microscale.

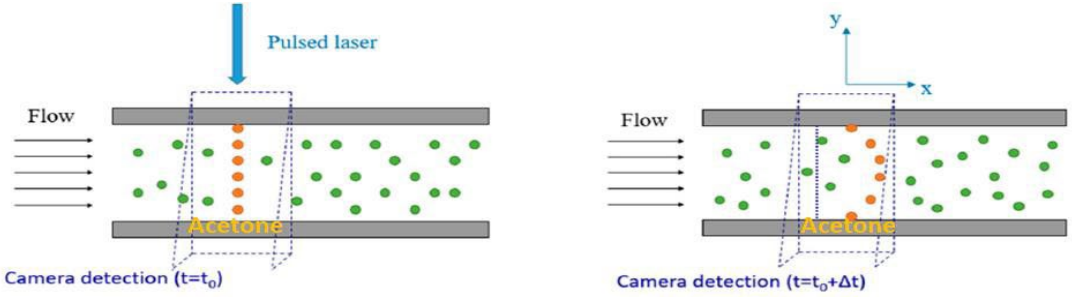

Figure 1. Basic principle of 1D-MTV by direct phosphorescence of acetone, for a gas flowing in a plane channel

The microfluidics team of ICA has been developing MTV in the scope of rarefied gas flow investigation since 2009. Several theses have been performed in the microfluidics team, leading to the development of the technique and as results to retrieve 1D velocity profiles in a millimetric channel for gas flow in hydrodynamic regime or to obtain first local velocimetry results in rarefied gas flows (slip velocity measurements close to the wall). However, improvements are needed to obtain correct velocity fields in rarefied gas by measuring molecular displacement, especially in order to adapt the technique to 2D measurements.

Objectives

This work aims to identify and improve the limitations of the current MTV technique developed for 1D velocity field measurements in order to prepare 2D diagnostics. It will result in decreasing the current uncertainties related to existing 1D-MTV results, by improving the data treatment and analysis using prior knowledge regarding the flow and properties of the gas through extensive collaboration of microfluidics and imagery expertise.

Starting date: 1st of March 2024
Location: Institut Clément Ader, Toulouse, France.
Salary:

- 600 €/month
- Financial aid for mobility will be provided for students coming from abroad (1x plane ticket)

More information (TU/e): Arjan Frijns