Development of an infrared absorption spectrometer based on new generation of quantum cascade laser diode in external cavity: application for kinetic studies

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Because of their broad gain, high power and narrow line width quantum cascade lasers (QCL) have become the most useful tunable infrared sources [1-2]. Recently, QCL in external cavity (ECQCL) were developed and present a large frequency range (~100 cm^{-1}). We report the development of a mid-infrared laser spectrometer (Fig.1) based on two new-generation commercial quantum cascade laser in external cavity (ECQCL) at 10.5 µm and 9.5 µm. The spectrometer is composed by a Fabry Perot cavity to obtain the relative frequency scale and a White type cell contained in a photo chemical reactor [3]. The characteristics (power, spectral, linewidth…) of each laser measured are presented and compared with an IRTF. We report the potentiality of the ECQCL for molecular spectroscopy application because of its large frequency tunability range, narrow linewidth and high sensitivity. The spectrum of several molecules (carbon dioxide, formic acid, ethanol and hydroxyacetone) which present an atmospheric interest are presented. About 100 rovibrational lines of CO_2 and HCOOH are measured and compared with literature. We present one application of ECQCL: the first kinetic study of hydroxyacetone with chlorine atom in function of temperature (280 to 350K) in the 1032-1106 cm^{-1} range. This study allows to determine the Arrhenius constant and to estimate the lifetime of hydroxyacetone in atmosphere.

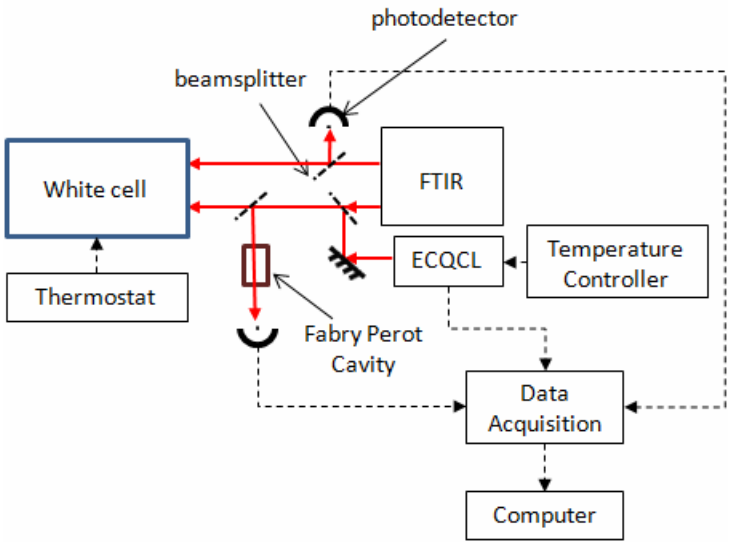

Fig.1 Spectrometer principle