# Thermo-hydrodynamics of multicomponent supercritical fluids flows in microreactors: a first step towards SCWO on a chip

*Deewakar Sharma[1], Arnaud Erriguible[1,2], Olivier Nguyen[1], Carole Lecoutre[1], Yves Garrabos[1], Uday Hegde[3], Michael Hicks[4], Samuel Marre[1]*

[1] ICMCB, CNRS, Univ. Bordeaux, Bordeaux INP, UMR 5026, F-33600, Pessac, France
[2] I2M, CNRS, Univ. Bordeaux, Bordeaux INP, UMR 5295, F-33600, Pessac
[3] Case Western Reserve University, Cleveland, OH 44135, USA
[4] NASA John H. Glenn Research Center, Cleveland, OH 44135, USA

Supercritical water oxidation (SCWO) has been identified as a promising technology to deal with organic waste for human space missions, starting with ISS followed by interplanetary missions [1]. With size and weight being constraint in any space mission, micro inserts can be considered as small size reactors to recycle and valorize the organic waste. The global objective thus lies in the development a microreactor to proceed with supercritical water oxidation at micro scale (µSCWO). This is further motivated by the inherit advantages of working at small scales such as, smaller reaction time scales and uniformity in reaction. In the framework to develop the aforementioned system, the current study aims at studying the cold combustion process in supercritical water (T < 600°C, P < 300 bar). One of the primary challenges to develop such a system concerns the appropriate choice of material for the microreactor, which should exhibit compatibility in terms of mechanical and thermal strength at the operating conditions but is chemical inertia with supercritical water. In order to address this issue, a sapphire based micro-reactor developed at ICMCB-Bordeaux [2] is proposed for experiments, whose schematic is shown in Fig. 1

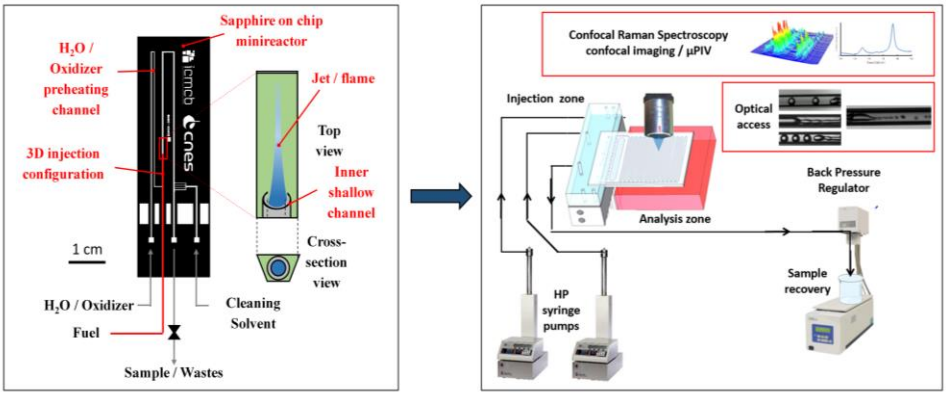


Figure 1: Schematic of the micro-chip and experimental setup

With efficient mixing being a desired condition in case of diffusion flames (combustion), the first step aims at analyzing the thermo-hydrodynamics of the multi-component fluid systems at high-pressure in a micro-reactor, in particular the mixing dynamics. The significance of high pressure lies in behavior of various thermophysical properties. We have previously analyzed the hydrodynamics and mixing behavior in a model fluid system ($CO_2$-ethanol monophasic) at isothermal conditions [3]. They identified new jetting mode for co-flow injection, mostly driven by inertia. Further, the mixing time associated with co-flowing fluids was determined by numerical simulations at both laminar and turbulent conditions. We also proposed a general phase diagram to categorize the jet breakup mechanisms based on the inner and outer fluid inertial forces.

Moving along the similar lines, the current work seeks to study thermo-hydrodynamic behavior of supercritical water, ethanol and oxygen which is representative of a realistic system to be used for µSCWO. Before moving towards experiments, it is essential to design the microchip suited to achieve efficient mixing conditions. This is performed with the help of numerical simulations, which provide insights into the mixing behavior. The model is further used to study reaction mechanics using global reaction assisting in appropriate design of the microreactor.

## References

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