Micro-channel heat transfer using spinoidal liquid-liquid mixture

PhD Student: Dario Giuseppe Urbano (d.urbano@unibs.it)
Advisor: Prof. Adriano Maria Lezzi

It is proposed an experimental study of liquid/liquid phase separation heat transfer at the microscale using triethylamine (TEA)/water solvent mixture.

The main objective of the study is to investigate better both the enhancement of heat transfer and the decreasing of pressure drop that take place in this partially miscible liquid liquid mixture in micro heat exchanger, when spinodal separation occurs.

Spinoidal decomposition is a mechanism by which a mixture of two components can separate into distinct phases with a different chemical compositions and physical properties. This mechanism is similar to nucleation but different because phase separation due to spinodal decomposition is much more subtle and occurs uniformly throughout the material, not just in discrete nucleation sites.

From a more practical standpoint, spinodal decomposition provides a means of producing a very finely dispersed microstructure that can significantly enhance the physical and thermodynamical properties of the material. In thermodynamics this capability of produce a very subtle and dispersed structure can be used to improve heat exchange in multiphase mixtures.

It would be very interesting to try to take advantage of this movement induced by spinodal decomposition to *enhance* the *heat exchange* in *micro-devices*. This possibility could be very attractive opportunities for microelectronics industry.

The global tendency towards miniaturization driven by the micro-electronics industry, indeed, is pushing system density and packaging towards unprecedented values of thermal design power, with a dramatic reduction of the surface area of the devices. As such, the thermal management of these systems requires novel and smarter cooling methods, in particular in view of the next generation of 3D integrated circuits.

Two-phase microfluidic cooling systems are very investigated because the latent heat during liquid-vapour phase change absorbs large fluxes, but there are several problems linked to liquid-vapour instabilities during phase-change that lead to local dry-out, non uniform temperature distributions and significant decreases in critical heat flux.

In this scenario, using a LCST (Low Critical Solution Temperature) liquid liquid mixture, like TEA-water, could let to reach the required cooling performance, without all difficulties to use a two-phase fluid.