ED SMAER
Thesis subject 2013

Laboratory	:	FAST (UPMC, U-Psud, CNRS) Bat 502, Campus Universitaire, 91400 Orsay http://www.fast.u-psud.fr/
Supervisor :		Véronique Lazarus (Maître de conférences à l'UPMC, membre de l'Institut universitaire de France.)
Title:		**Experimental study of thermal cracks in hard caramel layers**
Contact	:	veronique.lazarus@upmc.fr
Tel	:	01 69 15 80 39
This subject		can be published on the doctoral school's website: yes

Example of crack patterns obtained during caramel quenching

Retraction cracks are very common in the Earth and other planets (Mars) but also in industrial applications. They occur within a wide range of scales and materials, e.g. during the drying of suspensions (paints, mud, cosmetics) or the cooling of ceramics (thermal barriers for gas turbines and aero-engine parts), Micro-Electro -Mechanical- Systems (MEMS), soils (permafrost) or lava layers (basalt columns). Controlled fracture networks induced through thermal shocks are also an efficient mean for enhancing heat exchange in geothermal energy generation. Hence, better understanding and control of retraction crack formation would be very useful to a transdisciplinary community ranging from geophysics to material science.

Our aim is to provide cost effective experiments specially designed to fulfill this point. One difficulty is to find some material which is sensitive enough to thermal dilatation while at the same time being brittle enough to undergo fracture. Hard caramel satisfies these points. Layers of controlled thickness can easily be obtained by melting some sugar in a micro-owen and then let it cool at ambient temperature. Cold water pulled on the surface is then enough to form some nice and complex crack patterns (see figure).

The objectives of the PhD is to perform those experiments systematically. The control parameter will be the thickness of the layer and the temperature gradient. Attempts will also be done to deal with the initiation process by introducing some defects under a controlled manner (substrat patterning, bubbles). The outputs will be the crack pattern formation. In parallel, it will be necessary to perform some characterization of the material constants. Depending on the student interests, some numerical simulations of the problem may also be performed.