


Internship proposal 2011-2012

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From nano to macro-scales: new tools to identify hidden properties of liquids

Scientific project : THE LIQUID STATE IS THE MOST SPREAD ON THE EARTH'S SURFACE, IT PLAYS THE MOST CRUCIAL ROLE IN THE CHAIN OF LIFE, BUT IT IS ALSO THE LESS UNDERSTOOD. THEIR PUZZLING PROPERTIES FASCINATE FROM THE NANO TO MACROSCALE WITH UNPREDICTABLE EXTRA LONG TIME RELAXATIONS, SPECTACULAR SHEAR-INDUCED TRANSITIONS[1], SHORT LENGTH SCALE MICROFLUIDICS INCOMPATIBLE WITH THE MACROSCOPIC SCALE.

WE HAVE RECENTLY IDENTIFIED IN VISCOUS LIQUIDS, FAR FROM ANY TRANSITION, SO FAR UNKNOWN SOLID-LIKE CORRELATIONS[2,3]. THE "LIQUIDS" CONTAIN ACTUALLY A NON-NEGLECTIBLE SOLID CHARACTER. THESE ELASTIC CORRELATIONS MAY GOVERN THE FLUIDIC STATE AND EXPLAIN SOME OF THE PHENOMENA DESCRIBED ABOVE. FOR EXAMPLE, IN THE CASE OF POLYMER MELT DYNAMICS, IT TELLS THAT TIME & LENGTH SCALES MUCH LARGER THAN THE CLASSICAL VISCOELASTIC TIMES (ROUSE, REPTATION) AND THAN THE CHAIN DIMENSIONS EXIST.

IT IS NOW URGENT TO IDENTIFY THE MOLECULAR PARAMETERS GOVERNING THIS SUPRAMOLECULAR COHESION. IN PARTICULAR, IT IS NECESSARY TO EXAMINE THE CORRELATION RANGE OF THE ELASTIC FORCES AND TO CONNECT IT TO THE DISCONTINUITY FROM NANOSCOPIC TO MACROSCOPIC SCALE DYNAMICS (NANO-SCALE PROPERTIES EXHIBIT SOLID-LIKE FEATURES WHILE AT MACROSCOPIC SCALE, THE RESPONSE IS VISCOUS OR VISCOELASTIC). PLAYING WITH THE MOLECULAR ARCHITECTURE, DETERMINING THE CHARACTERISTIC TIMES & LENGTH SCALES, THE VISCOELASTIC MODULI (USING A NEW PROTOCOL (CEA PATENT[2])) AND THE ASSOCIATED STRUCTURAL ORGANISATION, SHOULD ALLOW TO PROGRESS RAPIDLY IN THE ANALYSIS OF THIS NOVEL DYNAMIC. *IN SITU* NEUTRON SCATTERING STUDIES AT SMALL AND AT BROAD ANGLES WILL PROVIDE UNIQUE INFORMATION ON THE MOLECULAR GEOMETRY UNDER CONSTRAINT.

PRACTICAL CONSEQUENCES OF THE CONSIDERATION OF LONG RANGE ELASTIC FORCES IN THE LIQUID STATE ARE NUMEROUS AND DIRECT IN VARIOUS ACTIVITY AREAS INVOLVING INTERFACIAL MECHANISMS (ADHESION, MOULDING, LUBRIFICATION, COATING, AND FLUIDICS).

THIS SUBJECT WILL BE IDEALLY DEVELOPED IN THE FRAME OF A MASTER TRAINING.

1. J.F. BERRET ET AL, EUROPHYS. LETT. **25** (1994) 521, V. SCHMITT ET AL, LANGMUIR **10** (1994) 955, C. PUJOLLE-ROBIC, L. NOIREZ, NATURE **409** (2001) 167, H.WU, S. GRANIC, SCIENCE **258** (1992) 1339.

2. PATENT 05 10988 (2005).

3. L. NOIREZ, P. BARONI, J. MOL. STRUCT., **972** (2010) 16 AND REFERENCES THEREIN, H. MENDIL, JOLIOT-CURIE PRIZE 2007.

Techniques in use: Dynamic relaxation, non-linear micro-rheology, neutron scattering.

Applicant skills: physics of liquids, materials, surfaces, physico-chemistry, signal analysis.

Granted internship: yes (_____€/month)

C'nano IdF laboratory (France only) : yes / no

PhD - thesis : yes (type of grant : CFR -1650 €/month)