EQUIPE MATÉRIAUX ÉCO-COMPATIBLES

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RESEARCH INTERESTS

I/ Nanostructured synthetic polymers. Organic/inorganic nanostructured hybrid composites. Nanoconfinement effects. Chemical reactivity of nanoconfined systems. Epoxy and polyurethanes cures, polymerizations reactions, sol-gel reactions, crystallization and relaxation of polymers, glass transition, thermal and thermo-oxidative degradation. Kinetic aspects of the glass transition of nanoconfined polymers and composites.

II/ New polymers from biomass and biomass based nanocomposites. Furan and lignin based materials: polymers, composites and organic/inorganic nano-hybrids from 2nd generation biomass. Developed new binders based on renewable resources such as furfuryl alcohol. Elaboration and characterization of new polyfurfuryl alcohol/silica organic/inorganic nanohybrid synthesized via sol-gel process. Elaboration and characterization of new layered silicate nanocomposite with lignin/natural fibers.

III/ Kinetic analysis of thermally stimulated processes by using calorimetric, thermal analysis and rheometric data. Pr N. Sbirrazzuoli have contributed to develop kinetic analysis of thermal data and "Model-free kinetics"– a system of novel methods for kinetic analysis of thermally stimulated reactions in the condensed phase. Numerical methods. Developed softwares for signal acquisition, kinetic analysis of thermal and calorimetric data. Thermodynamics and kinetics of phase transitions (melting, crystallization kinetics). New nucleating agents. Phase Change Materials for energy storage. Chemical reactions for energy storage. Enthalpy of chemical reactions and physical transitions. Heat capacity measurements in isothermal, nonisothermal and quasi-isothermal modes. New method for crystallization kinetics.

KNOW- HOW

High expertise in thermoanalytical investigations

Thermal analysis includes a wide range of techniques based on the measurement of a physical property with time at well defined temperature (isothermal mode) or temperature (non-isothermal mode). It is possible to measure heat exchanges (DSC, calorimetry, micro-calorimetry), weight loss (TGA) and to analyze evolved gas (Evolved Gas Analysis, ATG-GC/MS, ATG-IR, ATG-MS). Information on complex viscosity, mechanical modulus (rheometry, DMA) and dielectric properties are also available. Various heating/cooling/constant temperature programs can be used with a temperature range between -150°C and +1600°C. Complex temperature program (sinusoidal or stochastic) associated with special mathematical treatments are used to obtain additional information on physical and chemical complex transformations. Typical heating/cooling rates vary between ± 0.02 to ± 50 K/min, but new technologies make it possible to perform measurements at cooling/heating rates up to 240 000/2400 000 K/min. All these measurements can be performed under defined and controlled atmosphere (control of humidity or oxygen, solid-gas reactions, degradations, oxidations …).

Polymer and physical chemistry

Internationally recognized expertise in the synthesis and physico-chemical characterization of organic, hybrid organic/inorganic, polymeric and biomass-based materials with specific properties. Application of thermal analysis, calorimetry and rheometry to a variety of polymeric materials, including liquid crystalline, nanostructured, biodegradable, renewable polymers and biopolymers, phase change materials for energy storage. Kinetics of complex reactions, physical transitions (melting, first order transitions, crystallization and glass transition) and complex chemical reactions involving physical transitions. Reactions controlled by diffusion. Chemorheological analysis of complex reactions and mechanical characterizations. Thermal and thermo-oxidative degradation of polymers and biopolymers. Dispersions of nanoparticles in highly viscous solutions. Eco-friendly products and processes.

Equipments of the team

Thermogravimetric Analysis (TGA, 20 – 1600°C, 0,1 microgram), Coupling TGA/GC-MS
Differential Scanning Calorimetry (DSC, -70°C; 800°C)
Temperature Modulated DSC (TMDSC) and Stochastic Temperature Perturbation DSC (TOPEM®)
Reaction Calorimetry (RC) and C80
Dynamic Rheometry, Dynamic Rheometer-DMA with strain convection heating (-150°C; 600°C).
Mechanical test (tensile or flexural tests, compression).
Thermo-microscopy, polarized light (-150 ; 350°C) and images treatment software.
New Flash DSC, heating/cooling rate up to 2 400 000 K/min/240 000 K/min (-95 ° to 450 °C).

Other equipments

AFM, NMR 500 MHz, MS Finnigan MAT LCQ, GC/MS, LC/MS, API, APCI, Electronic Microscopy Center, Center for Molecular Imaging and Modelisation, Nanorheology Center, CPV and HPLC apparatus, GPC apparatus with refractometer detector, FTIR, Tensiometer K100, Viscosimeter, Micro-wave reactor, Optical microscope (heating device, polarised light, image processing), Pressure hydrogenator, GC/MS (IE and IC), FTMS (FT-ICR), Goniometer, FTIR with variable temperature ATR, Ultra sonic extractor and sonicators, Furnace 1400°C, ICP-MS.