The present research project concerns the development of an emerging and multidisciplinary thematic area resulting from interactions between two research themes: "Molecular Materials" (CIEL, UMR CNRS 6521) and "Composite materials and polymers" (IRDL – UMR CNRS 6027). The project aims at developing a new generation of multifunctional hybrid materials for potential applications in molecular electronics.

Objectives. Today, many switchable materials have been synthesised and described in the literature, but the impact of rheological (mainly viscoelastic properties) and/or physical properties (conductivity, luminescence, electro- and photo-active phenomena, etc.) of organic polymers on the spin crossover (SCO) behaviour is very scarcely reported. The use of such polymers in the presence of spin crossover (SCO) molecular chains revealed, through very recent preliminary results obtained by the two groups involved in this project, a highly innovative strategy leading to the first viscoelastic switchable materials. However, the magnetic properties of the first viscoelastic systems obtained have shown that the fraction of active Fe(II) metal ions is not significant. In order to control the concentration of active SCO centers in these materials and to obtain cooperative viscoelastic systems, systematic studies to vary the Fe(II) concentration in the polymer matrices having different mechanical and/or physical properties have been considered. This approach will also allow to investigate the competition (or synergy) between switching and rheological as well as and physical properties of the polymer matrix.

Novelty of the project. Responsive organic polymers have drawn remarkable attention as materials that can change their structure and intrinsic properties under various external stimuli (e.g. T, pH, hν, salt concentration). Besides, certain inorganic entities, such as opto-magnetic complexes, can show switchable properties, which could be very interesting to combine with responsive polymers in order to design double-switchable multifunctional materials as novel examples for reconfigurable matter. In this context, the original approach of the present project aims notably at covalently or electrostatically grafting spin crossover or fluorescent metal complexes (e.g. 1,2,4-triazole derivatives) onto stimuli-responsive polymers (such as poly(N-isopropylacrylamide)), with the objective of synergistically combining magnetic/optical switching and responsiveness in order to control the complex properties of the hybrid material by the polymer response, and vice-versa.

Expectations. Due to its multidisciplinary and innovative character, this research project with high socio-economic impact defines undeniably a favourable environment for research training of PhD students, while contributing to the international reputation of the two host research groups. Unexplored in a systematic way up to now, this approach positions this PhD proposal as a main contribution to the state of the art in a research field with strong international emulation and significant potential applications. More precisely, the targeted applications are in molecular electronics, with an opening towards the development of new multifunctional materials focusing on the polymer impact on the resulting properties of these new materials. Patents and/or the establishment of appropriate industrial partnerships are expected.

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