Please use the following format for <u>the title of the file</u> so as to ease the management of the web site.

ECXX_LABYY_ NOMChercheur_ Numer
ECXX = ECLi, ECL, ECM, ECN, CS
LABYY = acronyme du laboratoire
NOMChercheur = nom du chercheur émetteur du sujet
Numer = numéro de la proposition (01, 02, é .) pour le chercheur

PhD Proposal 2017

School: CentraleSupelec	
Laboratory: LMSSMAT	**Web site:**
Team: Nanotube and nano/microcomposites	**Head of the team: Jinbo Bai**
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Collaboration with other partner during this PhD: **In France:**	**In China:**

Title: High performance polymer composites toughened by nano/micro hybrids
Scientific field: Material Sciences
Key words: Polymer composites, nano/micro hybrids, Toughening, Mechanical properties, Numerical simulation.

<u>Details for the subject:</u>

Background, Context:

Polymer matrix composites play increasingly important roles in the fields ranging from automotive, aviation, recreation, construction, medicine, industrial infrastructure. This is mainly due to their light weight and excellent properties. In general, a composite is engineered from two or more constituent materials with significantly different physical or chemical properties. The constituent materials are commonly classified into two categories: matrix and reinforcement. The combination of different matrix and reinforcement could thus generate a huge variety of composites which exhibit completely different properties. Among them, thermosetting polymer like epoxy is one of the most widely used polymer matrices. However, these cured thermoset composites tend to be rather brittle due to their high cross-link density and are therefore show low damage resistance. In recent years, a considerable amount of work has been undertaken in an attempt to enhance the toughness of these materials by incorporating a second phase such as rubber particles, thermoplastic particles or mineral fillers.[1]

The toughening efficiency of reinforcing fillers in composites depends on their size, and is directly proportional to the filler surface area to volume ratio. One of these features relates to the interfacial area between the matrix and the filler. Such region has different properties to the bulk matrix due to polymerï particle interactions. [1]

Comparing with conventionally used micrometric fillers, nanosized materials such as nanotubes show significantly improved reinforcing effects. This is mainly due to the fact that the large number density of particles per volume (typically 10^6 ï 10^8 particles/mm^3), the distance between particles (typically 10ï 50 nm at 1ï8 vol % inclusion) is comparable to the size of the interfacial region [2]. Hence, the interfacial regionôs volume fraction is significantly augmented when compared to the one of the microparticle reinforced composites. However, the carbon nanomaterials are difficult to be homogeneously dispersed into the polymer matrix due to strong agglomeration tendency.

Continuous improvement of damage resistance of polymer composites is highly desired to enlarge furthermore their applications. The nano/micrometer hybrid structures [3] could provide an efficient way to overcome the preparation obstacles of nanocomposites. Therefore, the main objective of this thesis is to develop highly toughened epoxy polymer composites using nano/micrometer hybrid fillers by exploiting multiscale reinforcing mechanisms.

Research subject, work plan:

The research subject of this thesis concerns hierarchical polymeric composites and their toughening mechanism investigation by experimental characterizations and micromechanical modeling. One kind of hybrids consisting of carbon nanotubes and ceramic microparticles will be chosen as reinforcing fillers [4-5].

To achieve the above mentioned objective, the following work plan has been defined.

(1) Study the influence of the hybrid structure, morphology, surface area and properties, and aspect ratio on the toughening effects of the composites.

(2) Characterize the interfacial region size and property by high resolution microscopy techniques.

(3) Model micromechanical behaviors of the composites to understand the hierarchical toughening mechanisms.

The proposed project is a multidisciplinary research topic which involves interfacial chemistry, materials treatment and engineering and heterogeneous structure mechanics. At the same time, a multi-scale characterisation approach will be used to systematically investigate the material performance in micro, meso and macrometer scales. A particular attention will be paid on the interfacial chemistry influence on composite toughening effects.

This is a challenging but very interesting research topic. We call for highly motivated candidates who have solid knowledge of polymer science.

References:

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