PhD proposal M/F

Implementation and characterization of polymer materials with self-healing behavior to provide the electrical isolation functions of integrated power modules

Ref JCB_PhD_2019LAPLACE

Industrial Partner:	MITSUBISHI ELECTRIC R&D CENTRE EUROPE (MERCE)
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Academic Partner	Université Paul Sabatier, Laboratoire Laplace UMR 5213
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Type of contrat:	3 years contract, from October 2019
Reference:	JCB_PhD_2019LAPLACE
Research topic:	Self-healing insulating material for power electronics

Subject proposed by:	Julio BRANDELERO, Mitsubishi Electric R&D Centre Europe, Rennes
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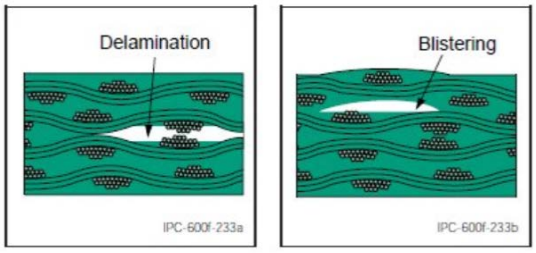
Context:

Power converters must ensure the convention of electrical energy in a volume increasingly reduced and with a required reliability that continues to grow. The semiconductor-based active component constitutes the basic brick. This component is naturally surrounded by functionalities related to its control, its cooling (transfer and diffusion of the heat flow), its electrical insulation, its mechanical maintenance, its hermeticity ... which constitute as many problems that we summarize under the generic term "packaging".

Active power components have ever-increasing performances (case of wideband gap components for example). These performances impose constraints around the semiconductor, a reduction of the elements described as parasites. As another example, we can mention the higher operating temperature of the components. Thus, the heat-sinks size may be reduced, however it introduces a concentration of the heat flux that must still be dissipated. In the same way, one can also mention the presence of significant thermal gradients that can be the cause of delamination or premature aging of the assembly of the component with its environment and lead to a dielectric breakdown. Delamination time is a measure of the time required for resin and copper, or resin and reinforcement, to separate or delaminate, see Figure 1.



Adapted from IPC-A-600

Figure 1: CPI Acceptability Standard for Printed Circuits

Objectives:

It is obvious that a minor mechanical failure can cause a major electrical type failure (partial discharges, dielectric breakdown). Thus, a material capable of fixing a "mechanical" defect may limit the impact on the dielectric properties and thus allowing to improve the reliability and availability of the system in which it operates.

The main targets are to identify how the restoration abilities of polymer materials imply their mechanical and dielectric characteristics, as well to determine the materials for insulation applications in active power components.

Thesis conditions and development:

Thesis starts:

From October 2019.

Presence:

Mainly at the laboratory Laplace in Toulouse (75% time).

Regular visits are planned to Mitsubishi Electric R&D Centre Europe, Rennes.

Planning & reporting

The work program is divided as follows:

T1: Identification of Compatible principles and materials

T2: Preparation of materials

T3: Realization of demonstrators

R: Thesis writing

Monthly reports (1 page) and quarterly meetings (alternately in Toulouse and Rennes).

Education and experience required:

- Engineer's degree or Master's degree with a focus in Materials Science or Electric Engineer
- Experience in an academic or industrial research environment
- Strong general scientific knowledge and multidisciplinary opening (electrical, mechanical, thermal, chemical, mathematical)
- Power electronics skills would be a plus
- Communication and writing skills in English
- Motivation and dynamism to work in a research environment
- Ability to work in a multicultural and international environment

Send your CV and motivation letter in a pdf format by mail (by specifying in object: your name and the reference JCB_PhD_2019LAPLACE):

jobs@fr.merce.mee.com

References:

1. D.G. Bekas, K. Tsirka, D. Baltzis, A.S. Paipetis, "Self-healing materials: A review of advances in materials, evaluation, characterization and monitoring techniques", Composites Part B 87, 92-119, 2016.

2. J.H. Tortai, A.Denat, N. Bonifaci, "Self-healing of capacitors with metallized film technology: experimental observations and theoretical model", J. Electrostatics 53, 159-169, 2001.

3. R. Rhodes, I. German, S. Basu, G.C. Stevens, "Self-healing materials for autonomous cable repair", CIRED, Open Access Proc. J., Vol. 2017, Iss. 1, pp. 420–423, 2017.

4. I.N.N Jahnavi, B.R. Bhanuprasad, S. Pavan, M.S. Koti, "Self-healing in electrical domain", Internat. J. Scientific & Eng. Research, Volume 7, pp. 197-201, 2016.