LABORATOIRE de MECANIQUE de LILLE UMR CNRS 8107

Job offer

NAMIS International Research Group

Position: Post-doc
Expected starting date period: September, 1st , 2007
Duration: 12 months
Deadline of this proposal : April, 30th , 2007

Kinematic and thermal fields coupled measurements at the grain scale in polycrystals - Application to the silicon polycrystals of microsystems (MEMS)

Summary of research/technical work :

Since a few years, MEMS developments and purposes greatly intensify and therefore, reliability becomes an important design aspect. In this framework, scientific works recently address the fatigue problem (i.e. damage under cyclic loadings). Most of the results are obtained under in-situ conditions, i.e. on micro devices including the tested system and the loading capabilities, for different type of loadings (tension with electrostatic grip system or thermal loading, bending under nanoindentation …) and the estimation of stresses or strains is often indirect. In Lille (France), Buchaillot's team (IEMN – UMR CNRS 8520, France) works on microsystems development and on this type of fatigue tests with plane bending or nanoindentation. However, in all those works, the analysis of the deformation and damage mechanisms is often uncompleted and this is due to the difficulties of measurements and observations in-situ.

An analysis of deformation and damage mechanisms of such microsystems, a complete modelling and the prediction of their reliability seems to be considered from the theoretical and experimental works on dissipation and fatigue started up since a few years in our team, in the Laboratory of Mechanics in Lille (LML – UMR CNRS 8107, France). In particular:
- the measurement of kinematic and thermal fields under cyclic loadings at the grain scale with optical and infrared cameras,
- the simultaneous realisation of such measurements in the same area.
The originality of the method called KiTCAM (KInematic-Thermal Coupled Analysis Method) consists in the local scale and the coupling of those measurements. Then, in the case of the infrared thermography, the geometric resolution is close to 30 µm and, in the case of the optical camera, the geometric resolution is close to 7-10 µm. The experimental device enables the coupling of both cameras by using a mirror filter which transmits the infrared radiation and reflects the optical one. The first tests, under monotonic loadings, were realised and the results are very promising

Post-Doc objectives:

In order to study the microsystems fatigue phenomenon, some adaptations of the KITCAM method are necessary. Instead of in-situ tests where observations are difficult, the proposed approach consists in the realisation of micro-specimens mechanically loaded. The tests suppose a micro machine whose acquisition is considered, in collaboration with L. Buchaillot. The KiTCAM analysis is then possible provided some adaptations which compose the Post-Doc subject:

- the realisation of the micro specimens, composed by a few micrometers thickness and a few square millimetre surface gauge section and an integrated grip system, can be realised at IEMN lab, directly from a silicon plate. The conception and the design of such a device have to be realised in order to be tested under cyclic loadings.
- in such testing conditions, the KiTCAM method suppose a new conception of the existing platform enabling the movement, the coupling and the synchronisation of both cameras.
- the complete treatment of the infrared thermography measurements involves the use of the displacement fields, determined by optical images correlation in order to follow the same material points (eulerian-lagrangian coupling as for Particle Image Velocimetry in fluid mechanics).

At the end of this Post-Doc, we certainly must dispose of a test device, unique to our knowledge, allowing the determination of the local kinematic and thermal fields in polycrystals, at a very small scale, giving indications on the damage mechanisms in MEMS. This study is a first collaboration between IEMN (L. Buchaillot, Research Director, CNRS) and LML (E. Charkaluk, Research Fellow, CNRS and L. Sabatier, Research Engineer, CNRS).

Required knowledge of candidate:

Experimental technical skills, ideally in the fields' measurement by image analysis.
Good general knowledge of the mechanics and physics of solids.

Location and other practical information:

Location :
LML, Villeneuve d'Ascq, North of France
http://lmlm6-62.univ-lille1.fr/lml/

Gross salary : 2500 euros/month

How to apply : applicants have until April 30th 2007 to make contact with the Laboratoire de Mécanique de Lille and send it a completed application form. All the details are on the CNRS WEB site :

https://www2.cnrs.fr/DRH/post-docs07

Contact(s):

Eric CHARKALUK, CNRS - Université de Lille 1, Laboratoire de Mécanique de Lille

Mail : eric.charkaluk@univ-lille1.fr
Phone : +33 (0)3 20 33 71 82