Location :
Talence (Bordeaux)

Additional informations:
Position available from
15 September 2021
Unit of assignment :
I2M
Job category : not applicable
Type of contract: Post-doctorate
Duration of the contract: **24 months**

Application:
CV and cover letter to be sent by email to :
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Fracture behaviour of porous ceramics obtained by plasma spraying, in quasi-static and dynamic regimes.

Introduction

Because of their resistance to very high temperatures and pressures, ceramics have many applications in the aeronautics, automotive and aerospace industries, as well as in biomedical applications. This class of material makes it possible, among other things, to delay wear or corrosion when they are deposited in the form of coatings on metallic, polymer or composite substrates, to limit heat flow (thermal protection at high temperatures), or to maintain satisfactory mechanical strength when the materials are brought to high temperatures (engine turbines, combustion chambers). Another application of these coatings concerns the protection of sensitive materials such as optics or sensors placed in extreme environments in terms of temperature and velocity of impact of solid entities (particles or debris). The plasma spraying technique is particularly well suited to the implementation of ceramic coatings with thicknesses of the order of a few hundred microns. Indeed, this technique is based on a relatively simple principle (injection of a powder into a plasma jet formed by the conversion of electrical energy into thermal energy in a plasma arc torch) and it is well adapted to refractory materials such as ceramics thanks to the high temperatures (>10,000 K) and enthalpies (5-25 MJ/kg) of the plasma jet. However, these protective coatings remain relatively expensive for the time being because of the highly technical nature of the spraying methods to be used. Only a significant contribution in terms of, for example, thermal and mechanical performance in relation to the substrate can justify the use of these coatings in industry.

Context

The post-doctoral student recruited is part of a collaborative project between the I2M and the LCTS in Bordeaux, the IRCER in Limoges and the CEA, supported by the region. The CAPRIC-DYN project is part of this context of high-performance ceramic coatings. It focuses on a field that has not yet been fully explored for these coatings, namely their behaviour in the face of unsteady mechanical stresses (subsequently referred to as dynamic or impact stresses). We are particularly interested in the fracture mechanisms generated by these stresses. As the properties of these ceramic layers are closely linked to their microstructure (porosities, residual micro-cracks, lamellar or columnar structure) and to the residual stresses generated by the surface preparation and deposition stages, the project aims to study the link between the microstructure of the coatings and their properties at fracture. This will eventually allow the optimization of internal parameters of the ceramic structure to respond to particular stresses.

Objectives

The assumed quasi-brittle material will be characterised at different loading velocities. The planned post-doctoral fellow will be particularly interested in the study of the initiation (i.e. slow propagation) and rapid propagation of cracks that can be induced by quasi-static and dynamic loading of the specimen. Fracture tests in the opening mode (mode I), which is considered to be the most critical mode from a material point of view, will be carried out. The first step in the study will be to establish the resistance curve of the material based on cyclic servo-controlled crack opening tests on a "Compact Tension" type geometry. On this same geometry, fracture tests will be carried out at high loading velocities with original means (magnetic jack, inertia wheel). The resistance to rapid propagation will then be estimated from a geometry that allows the generation of a quasi-permanent regime of rapid propagation known as the "Strip Band Specimen". The influence of inertial effects induced either by the dynamic loading or by the fast crack propagation will be evaluated from the numerical twins of the experiments. The energy dissipated by the structure and the energy dissipated by the crack in the form of surface creation can then be dissociated. A detailed description of the microstructure and fracture surfaces at different scales of analysis will be carried out to try to understand the surface creation mechanisms. This will ultimately lead to the estimation of a material parameter, the fracture energy, which will be used in a predictive behaviour model. The post-doctoral fellow will also participate in the validation tests set up at the CEA using means such as a transportable laser shock generator (GCLT) at the CEA-DIF, a CESAR pulsed electron beam generator at the CEA/CESTA and an Intense Electrical Pressure Generator (GEPI) at the CEA/Gramat.

Skills required

The candidate will have a PhD and a good knowledge in mechanics of materials, fracture mechanics and/or structural dynamics with a strong taste for research in an industrial context and for experimental work. The post-doctoral fellow will also have to work in synergy with the other members of the project, especially the PhD students. Organisational, interpersonal and communication skills, both written and oral, are also required to successfully complete such a collaborative project.

Additional information

The post-doctoral fellowship will start at the end of 2021 and will last 24 months. It will take place in the Dynamics team of the DUMAS department of the I2M laboratory. The net monthly salary will be about 2600 euros (i.e. about 3250 €/gross). The application should include a CV, a cover letter, the articles written during the thesis or previous post-doc and the thesis reports, sent to the contacts in the header of the document. (In case the thesis is not defended, a letter of recommendation from the thesis director will be requested).