Institut franco-allemand
de recherches de Saint-Louis

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Research field: Materials Mechanics, Shocks, Mechanical testing and Numerical Simulation

# Study of the mechanical behaviour of a very high hardness alloy over a wide range of strain rates

## Context:

Testing a highly brittle alloy with a very high hardness at extremely high strain rates poses several major challenges.

On the one hand, the rapidity of fracture complicates the acquisition of reliable measurements, as there is very little time to record data without artefacts. Consequently, non-contact metrology techniques are mostly employed (digital image correlation, heterodyne velocimetry, etc.).

On the other hand, classic dynamic characterisation setups, such as Hopkinson bars, must be adapted to prevent premature fracture of the sample, ensure correct stress transmission, and protect the test apparatus from damage. Therefore, new types of tests must be developed to meet these specific requirements.

Moreover, the fragile nature of the alloy makes preparing homogeneous test specimens and achieving repeatable tests difficult, as any microscopic defect can trigger premature failure. Localisation of deformation (crack formation or shear band development) also hinders the attainment of homogeneous stress fields.

This necessitates coupling experiments with post-mortem characterisation techniques (e.g. scanning electron microscopy and CT tomography) and numerical simulations that replicate the tests in order to correctly interpret the results.

Within the framework of the Chocodyn Federation (https://chocodyn.cnrs.fr), of which ISL is an active member, this PhD project aims to investigate the mechanical behaviour of a very high hardness alloy over a very wide range of strain rates through experimental characterisation, appropriate modelling, and the detailed description of the mechanisms involved in an impact. To this end, the work will address the following points:

1. Literature review on experimental methods for characterising the behaviour and fracture of ultra-hard materials over a broad range of strain rates, and on the associated constitutive models.
2. Dynamic mechanical and fracture characterisation of the material of interest, including the development of specific mechanical tests. This study will benefit from the outstanding facilities of the partner laboratories of the Chocodyn Federation.
3. Modelling of the behaviour and selection of suitable numerical methods for simulating a ballistic impact.
4. Impact simulation and validation against experimental data.

## Candidate profile:

- An outstanding engineering or academic candidate with an excellent academic record.
- Master's degree (M2) in Materials Mechanics or Materials Science (mechanical specialization). Strong skills in numerical simulation, finite element methods, and a keen interest in experimental work are essential.
- Very good writing skills and proficiency in English.
- Strong integration, communication, and organisational abilities; scientific curiosity and dynamism.

## What we offer:

- A PhD project within a dynamic and international collaborative environment
- Access to state-of-the-art experimental facilities
- Competitive salary

## Localization

The PhD work will be performed mainly at ISL (Saint-Louis, France), with occasional visits to the partner laboratories.

## Supervising team

**Yaël DEMARTY**
Advanced Materials and Mechanical Testing Group
5 rue du Général Cassagnou – 68301 Saint-Louis
yael.demarty@isl.eu

**Anthony BRACQ**
Advanced Materials and Mechanical Testing Group
5 rue du Général Cassagnou – 68301 Saint-Louis
anthony.bracq@isl.eu

**Alexis RUSINEK**
LEM3 – UMR CNRS 7239 - Université de Lorraine
7 rue Felix Savart - 57070 Metz
alexis.rusinek@univ-lorraine.fr

**Laurent BERTHE**
Laboratoire PIMM – Arts et Métiers
151, boulevard de l'hôpital -75013 Paris
laurent.berthe@ensam.eu