

## Scratch behaviour of CuZr-based bulk metallic glasses

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### Jury :

Jean-Christophe SANGLEBOEUF, Professeur des Universités, Université de Rennes, IPR, Reviewer

Damien FABREGUE, Professeur des Universités, INSA Lyon, Mateis, Reviewer

Muriel VERON, Professeure des Universités, Grenoble INP, SIMaP, Examer

Jean-Jacques BLANDIN, Directeur de recherche, CNRS, SIMaP, Thesis supervisor

Alexis LENAIN, Directeur scientifique, Vulkam, Invited

Marc FIVEL, Directeur de recherche, CNRS, SIMaP, Invited

**Abstract :** This work aims at studying the scratch behavior of Bulk Metallic Glasses (BMGs). Those materials exhibit interesting mechanical properties such as very high yield strength and very specific deformation mechanisms. Indeed, the stress localization leading to the nucleation and propagation of Shear Bands (SBs) originates from their amorphous structure. The influence of those deformation mechanisms under specific and complex loading such as scratch test remains yet to be understood as the wear resulting of a BMG inside a complex device. To answer those interrogations, scratch tests were carried out on three different BMGs CuZr-based. The comparison of indentation and scratch tests revealed the importance of the shear strength for MGs.

Indeed, the introduction of a lateral force in the case of a scratch test induces the creation of SBs ahead of the tip of the indenter. The activation of the softening mechanism has also been pointed out, which leads to the sink in of the indenter during a scratch test. Thermal treatments of relaxation and partial crystallization were used to modify the structure of BMGs thus their mechanical properties. The study of these states revealed the importance of both the hardness and the fracture toughness. Thereby, the MG showing the best wear resistance is not necessarily the hardest MG, as often admitted. Thanks to the results obtained in this thesis, different strategies in agreement with the results shown in this work, are discussed in order to minimize the wear during the scratch of a MG.