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Dynamic behaviour and microstructural evolution of nitrogen alloyed austenitic stainless steels

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The aim of this thesis is to study the mechanical properties and associate microstructural evolution of a nitrogen austenitic stainless steel (Uranus B66).

Quasi-static (= 10^{-3} s^{-1}) and quasi-dynamic (= 1 s^{-1}) compression tests have been carried out with a traditional servo-hydraulic testing machine. Dynamic (= 10^{3} s^{-1}) compression tests have been performed on a classical split-Hopkinson bar equipment. These tests, which cover a great range of plastic strain, show that the material has a high strain hardening rate, good ductility and a great strain rate sensitivity. The temperature sensitivity has been determined in a large range going from –196°C to 400°C. Transmission Electron Microscopy (TEM) observations have been conducted in order to correlate the microstructure to the mechanical behaviour. Uranus B66 undergoes basically the same structure evolution during both quasi-static and dynamic compression tests. The plastic deformation takes place with planar glide and is followed by mechanical twinning.

The Johnson-Cook, Zerilli-Armstrong and the modified Zerilli-Armstrong models have been selected to represent the results of the investigated material into constitutive equations. The results obtained have been discussed and compared to the experimental data. It appears that the above-mentioned models do not reproduce correctly the behaviour of this type of steel in the complete strain range. We propose a new constitutive model which fits all the experimental data in the entire strain range, at different strains rates and temperatures. The model is based on empirical considerations on the individual influence of the main parameters. Single Taylor tests also have been realized in order to validate the proposed models.