LOW-VELOCITY SPALL TESTING OF TI-6AL-4V ALLOY AND NEW SPALL CRITERION BASED ON MESOSCALE

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This Interim Report covers the contract period from June 17/2002 to Sept.16/2002 (the first period of three months).The research in this Project is directed toward better understanding of the development of the local plastic fields occurring in mesoscale during spalling of Ti-6Al-4V alloy. The specimens in the form of disks of different thickness and DIA 57.0 mm have been delivered by AMSRL-WM-TA, APG Aberdeen, MD. Later, all specimens have been polished and measured in our Laboratory (LPMM). The plate-plate facility is in the stage of preparation. Since an observation on mesoscale is envisaged, more exactly, the surface topography after spall fracture will be analyzed, two new high resolution profilometers, one based on the light interferometry: WYKO NT1000 by VEECO and the second: MAHR profilometer, based on mechanical contact, have been put into operation. Both profilometers are equipped with a software which has been already tested . The software permits for a detailed analysis of 3D profiles. Preliminary analyses of the spall surfaces available after earlier experiments are in progress. The test results obtained for Ti-6Al-4V from experiments of shearing at high strain rates will be applied to identification of material constants in new temperature coupled constitutive relation.

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EXTENDED ABSTRACT

During the first period (three months from June17/2002 to Sept..16/2002) of the Contract the experimental program was setup to test Ti-6Al-4V alloy by so called plate-plate impact technique. The main purpose of this study is to clarify, using spall experiments, the role of short-time local plastic fields occurring in the meso-scale. The thermal coupling and the local high strain rates will be considered in the modeling.

The Laboratory of Physics and Mechanics of Materials is equipped, besides Hopkinson bars in compression and torsion, in the plate impact facility with bore diameter 57 mm. A flyer plate can be accelerated up to 800 m/s depending on the gas that is used. A series of spall tests are planned with different target/flyer thickness. A critical minimal impact velocity will be sought when the incipient spall occurs at loading times from ~600 ns to ~2.5 μs. The specimens in the form of disks of different thickness and DIA 57 mm have been delivered by AMSRL-WM-TA, APG Aberdeen, MD. The plate impact facility is in the stage of preparation, including an automatic procedure of the launching.

Since an observation of the spalled surfaces is envisaged, more exactly the surface topography in 3D, two new high resolution profilometers, one based on the light interferometry (laser interference): WYKO NT1000 by VEECO, and the second: MAHR Profilometer, based on mechanical contact, have been put into operation. Both profilometers are equipped in a sophisticated software which has been already tested. The software permits for a detailed analysis of the surface profiles in 3D including statistics. Preliminary analysis of the spall surfaces available after previous tests are in progress.

After previous projects on Ti-6Al-4V supported by the European Research Office of the US Army an ample data are available obtained in fast shearing which will permit to identify all material constants in a constitutive relation developed in LPMM.

During last years, within the framework of the previous projects on spall mechanics, advances in understanding fracture in the meso-scale are quite obvious. A review of fracture criteria will permit to make a correct choice for the Finite Element codes, [1]. Studies on mechanical and microstructural aspects of spall have provided further data on armor steels and hard aluminum alloy, [2,3]. A new model of spall fracture will be developed for Ti-6Al-4V based on the plate impact experiments, microscopic observations and topography analysis.

Refernces

[1] P.Chevrier and J.R.Klepaczko, Discussion of fracture criteria in spall mechanics, Eng. Trans., **45** (1997), 47.

[2] P;Chevrier and J.R.Klepaczko, Spall fracture, mechanical and microstructural aspects, Eng. Fract. Mech., **63** (1999), 273.

[3] J.R.Klepaczko and P.Chevrier, Fracture dynamics in one-dimensional strain, in: Modeling of Damage and Fracture Processes in Engineering Materials, IFTR, Warsaw, Poland, (1999), 90.

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