Non-standard experimental techniques for mechanical characterization of materials

Zbigniew L. Kowalewski

Institute of Fundamental Technological Research, ul. Pawińskiego 5B, 02-106 Warsaw, Poland
+48 22 826 12 81, zkowalew@ippt.pan.pl

The paper presents selected non-standard testing methods used for material properties assessments. It is divided into three parts. In the first one the yield surface concept was presented and discussed in detail. Yield loci are typically determined by testing a number of specimens which are loaded up to the plastic range along different stress paths. The yield stresses for a chosen plastic offset strain are determined from each stress-strain curve and plotted in stress space to give the yield locus. Alternatively, they can be obtained with the use of a single specimen loaded in many different stress directions, each time until some measurable and limited plastic strain is observed. At each point it is unloaded and reloaded in different direction until the entire yield locus is obtained. These directions differ from each other by a chosen angular increment, Fig.1.

In the second part of the paper a modern technique of compression/tension of thin metal sheets enabling deformation up to 10% without buckling effect is presented, Fig. 2. The compression tension fixture worked out at the IPPT enable us to avoid buckling during compression of specimens made of thin metal sheet. The fixture changes its length while a specimen elongate or shorten during a test and this is the main and characteristic feature of the fixture. The friction force which is generated due to a movement of both parts of the fixture is measured by a special strain gauge system during a test. Selected results of tests on different materials will be illustrated.

The last part of this paper presents dynamic testing technique of materials over a wide range of strain rates from ~ $5*10^2$ s^{-1} to ~10^4 s^{-1} . It uses so-called Split Hopkinson Pressure Bar (SHPB). In the testing stand for this technique a wafer specimen is placed between bars. In order to increase a range of strain rates to be measured up to 10^5 s^{-1}, the miniaturized Direct Impact Compression Testing stand was designed, produced and subsequently patented, Fig. 3. Modification in the mechanical part lies in the introduction of a decelerator tube in which a small Hopkinson bar with miniature SR gages is inserted. The original and not expensive optical technique to measure displacement of the interface striker-specimen has been applied. Combination of the quasi-static compression test, along with application of the SHPB and the miniaturized DICT, makes possible determination of the rate sensitivity of materials for very wide strain rate spectrum, from $5x10^{-4}$ to $5x10^5$ s^{-1} .

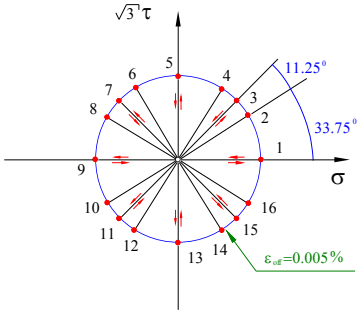

Fig. 1. Yield locus determination

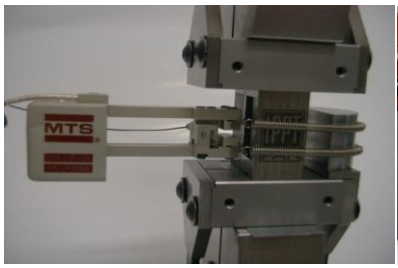

Fig.2. Anti-buckling fixture

Fig. 3. DICT testing stand