Beryllium Strength Studies Using the Perturbation Growth Method

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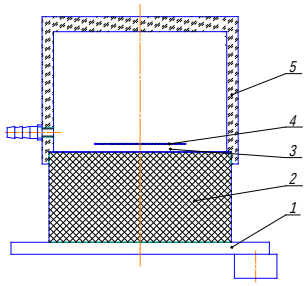
Introduction

The work is devoted to experimental and numerical-theoretical investigations of Be plastic deformation peculiarities under pressures up to P»50 GPa and strain rates $\dot{\varepsilon}$»$10^5 \div 10^6$ s^{-1}. To obtain data on shear strength of beryllium, the authors used the perturbation method [1], [2], which is based on X-ray radiography recording of perturbation growth specified on surface of a liner made of the investigated material. The perturbation growth is caused by the gravitational (Rayleigh-Taylor) instability, which takes place when loading (accelerating) the liner by explosion products. The physical base of the method is the dependence of growth of hydrodynamic instabilities on material shear strength.

Experimental setup

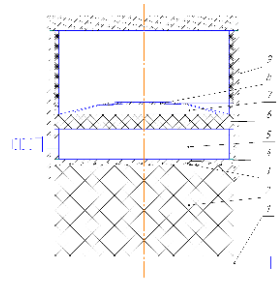
Figure 1 presents schemes of experimental assemblies, which provide quasi-isentropic loading of the beryllium liner up to pressures P»30 GPa and P»50 GPa. Typical X-ray images of the liners are shown in figure 2.

***P*»30 GPa**



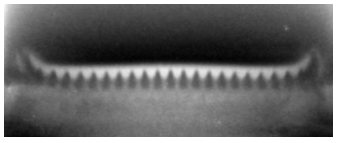
1 – generator of planar detonation wave;
2 - HE: Æ120´ 60 mm;
3 - vacuumized gap: d=2 mm;
4 – investigated liner: *Be*, Æ80´ 2 mm;
5 - sealing cylinder.

***P*»50 GPa**

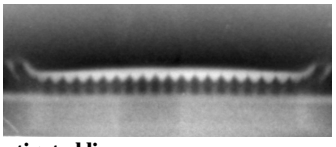


1 - generator of planar shock wave;
2 - HE of first stage: Æ120´ 90 mm;
3 - damper: plexiglass, Æ120´ 2 mm;
4 - impactor: *Fe*, Æ120´ 2.2 mm;
5 - vacuumized gap: d=20 mm;
6 - HE of second stage: Æ120´ 10 mm;
7 - vacuumized gap: d=2 mm;
8 - investigated liner: *Be*, Æ50´ 2 mm;
9 - sealing cylinder.

Figure 1, Schemes of experimental assemblies



P»30 GPa



P»50 GPa

Figure 2, X-ray photos of investigated liner

Numerical simulation setup

Numerical simulation of the experimental data was performed by the two-dimensional Lagrangian code DRAKON [3] using the Glushak phenomenological model of shear strength, which was similar to that used in works [4], [5]. Two variants of the constant sets – (1) and (2) – were used for the model. Figure 3

presents the dependence of yield strength on pressure behind the shock wave front with variants of the set of constants.

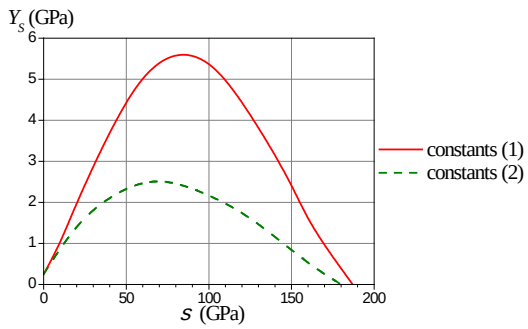


Figure 3, Dependence of yield strength on pressure behind SW front

Results

Figure 4 presents results of tests and simulations of perturbation growth in beryllium liners under quasi-isentropic loading up to pressures *P*»30 GPa and *P*»50 GPa with variants of the set of constants.

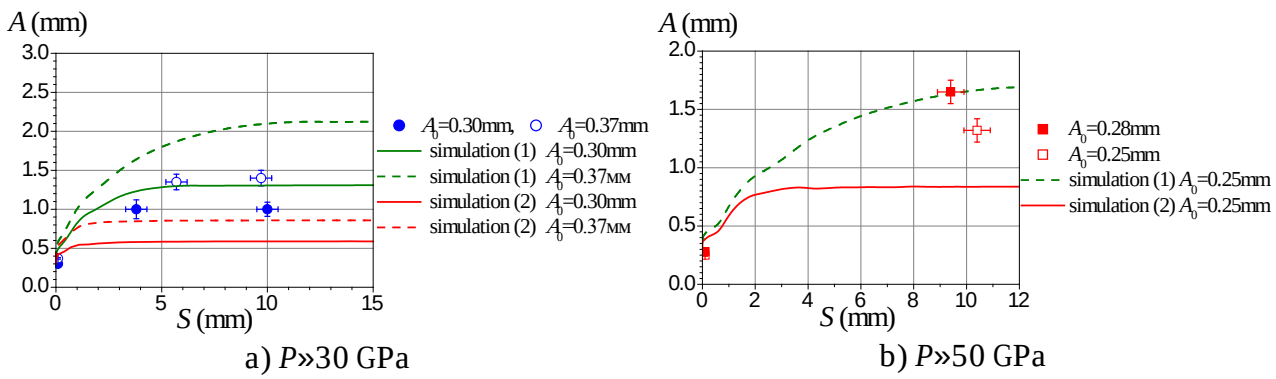


Figure 4, Results of tests and simulation of perturbation growth in beryllium

References

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