POSTER

THE DEFORMATION OF ELECTRODE GRAPHITE

Nikolay V. Negutorov and Valery G. Artelnykh

Joint Stock Company "Ural Electrode Institute"
160 Pobedy Ave., Chelyabinsk 454084, Russia

INTRODUCTION

Graphites have small fracture deformation and are thus considered elastic brittle materials. But it is well known that a graphite diagram of deformation may be an appreciably nonlinear curve (1, 2). In particular, the behaviour of the electrode graphites (EG) are not elastic (the nonlinear part of the deformation curve may reach 30-50 % of fracture deformation (3).

The significance of nonlinear deformation is very considerable for usage conditions. The nonlinear deformation decreases the level of thermal stresses in electrodes (4).

It is apparent that same physical processes produce nonelastic behaviour of graphite (5, 6). This processes may evolve on several levels of structure and exert various influence on the electrodes safety.

EXPERIMENTAL

The dimensions of the specimens for this investigation were 15 mm (diameter) and 80 mm (length of work zone). Specimens are subjected to uniaxial tensile loads and unloads. Stress-strain curves, cumulative count and amplitude of acoustic emission (AE) were recorded. The strain rate was 0.5 % per minute. The bulk density of EG was 1500-1750 kg/m^3. Average grain size was approximate of 2 mm.

RESULTS AND DISCUSSION

The typical diagram of deformation for EG grade is shown on Figure 1. AE is not registered by the apparatus up to the point 1. The macroscopic nonelasticity is not evident - there is no residual strain, the stress-strain curve is linear. Repeated small AE impulses appear above point 1. These impulses were initiated by numerous microcracks. After loading over point 2 residual strain is more than 0.002 % (it can be observed). Separate high amplitude impulses of AE appear above point 2. The monotony of the stress-strain diagram is broken by these big impulses. Above point 3 macrocracks are visible with growth in various directions. There is a final rupture of EG at the point 4. Experiments show that the bulk density is the most significant property in determine at the location of points at the diagram. The high density provides a short distance between the points 2, 3 and 4. The low density increases the nonlinear part of failure strain.

Stresses σ_1 and σ_2 are the main stresses to provide long life of electrodes. Macrocracks accumulate and the danger of sudden rupture increases rapidly beginning at these values.

The linear correlation between σ_2/σ_3 and bulk density is observed in the range of 1500-1750 kg/m^3. Above the stress σ_3 the mechanical behaviour of EG must be studied by methods of fracture mechanics with random cracks.

CONCLUSION

The combination of tensile tests of EG and AE recording gave strong correlation between the bulk density and the nonlinearity of stress-strain curve. This is very useful for providing of the electrodes safety.

REFERENCES

1. G.M.Jenkins, "Analysis of the stress-strain relationship in reactor grade graphite", J. Appl. Phys., Vol.13, No.1, p.30 (1962).
2. E.J.Seldin, "Stress-strain properties of polycrystalline graphite in tension and compression at room temperature", Carbon, Vol.4, No.2, p.177 (1966).
3. V.G.Artelnykh, N.V.Negutorov and Yu.I.Barkov, "The strains of electrode graphite", Tsvetnye metally, 1988, No.6, p.60.
4. N.V.Negutorov et al., "Thermal strength of electrodes", Tsvetnye metally, 1989, No.7, p.88.
5. K.E.Gillchrist and D.Wells, "Acoustic Emission from Graphite under stress", Carbon, Vol.7, No.5, p.627 (1969).
6. W.M.Gazda, "Variation in CTE as a function of prestressing", Carbon, Vol.8, No.4, p.511 (1970).

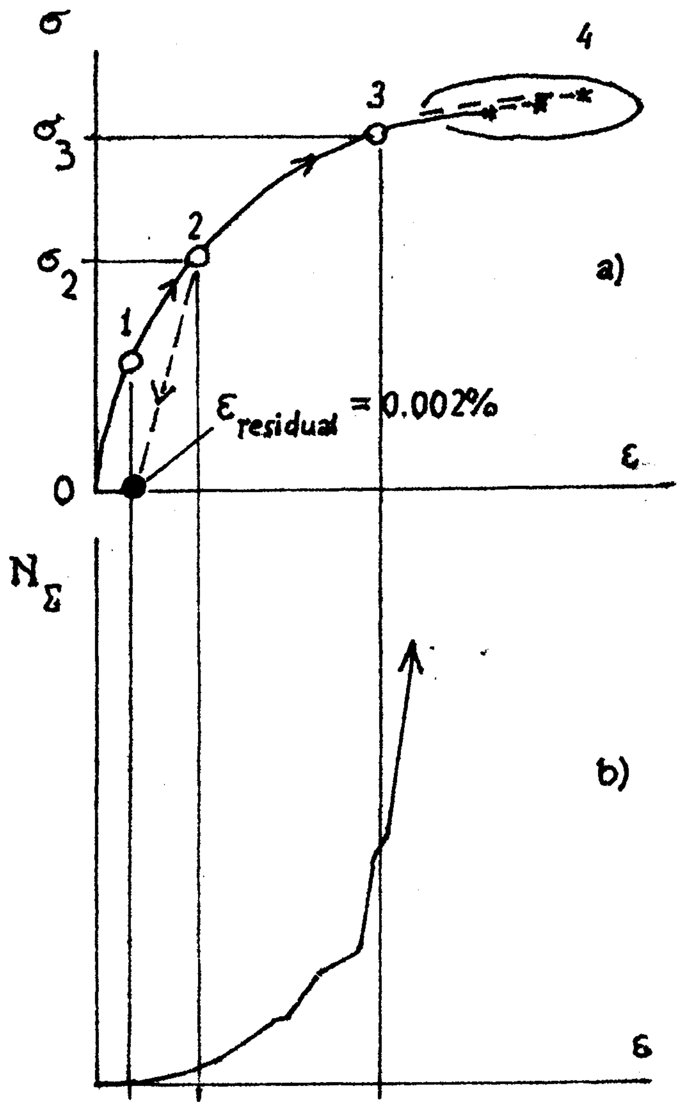

FIGURE 1: Stress-strain diagram for EG (a); N_Σ of AE - strain diagram (b); 1, 2 , 3 - stable points; 4 - non-stable region