

INVESTIGATION OF PLASTIC DEFORMATION OF BERYLLIUM SINGLE CRYSTALS SUBJECTED TO COMPRESSION

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An x-ray press-camera for studying plastic deformation of single-crystal and polycrystalline samples in the stressed state is described. The plastic deformation of beryllium single crystals of reagent grade purity was studied in this apparatus for three different orientations. The x-ray photographs obtained during various stages of deformation are associated with various portions of the deformation curves. On the basis of this investigation, certain conclusions have been reached concerning the mechanism of plastic deformation in beryllium.

As a rule, the elements of plasticity of single crystals are studied after deformation of the samples by special testing machines. Although one can, by this means, arrive at information concerning the type of plastic deformation the crystals have experienced (be it slipping, twinning, kinks, etc.), neither metallographic nor x-ray investigations performed on previously deformed samples yield sufficiently complete information about the mechanism or about the kinetics of these processes. Clearly a better way to identify the elements of plastic deformation or to study the kinetics of deformation or the failure mechanism of single crystals and also the only way to measure the magnitude of elastic deformation of the crystals by direct x-ray techniques is to x-ray the samples during the mechanical testing process.

In this paper we describe an x-ray investigation of the plastic deformation of single crystals of beryllium of various orientations. The selection of beryllium single crystals for this study was based on the specific plasticity of this material as well as on the search for new elements of plasticity in high-purity beryllium samples. In this paper we shall describe only the investigation of the kinetics of plastic deformation of single crystals of Be of reagent grade purity (99%) with well-known elements of plasticity: slip along the (0001) basal planes,

prisms of the first kind ($10\bar{1}0$), and twinning along the planes of pyramids of the first kind ($10\bar{1}2$).

A special x-ray camera [1] was constructed for this study of plastic deformation of these samples. It consisted of a compact mechanical press with automatic loading, equipped with a mechanism for simultaneously photographing the deformed samples "by transmission" and "reflection". The x-ray photographs could be made either at a fixed load or directly during the process of loading at a slow rate. Not only does this camera make it possible to x-ray the sample while it is deforming, but it also makes it possible to elucidate the shape of the deformation curve.

The x-raying of samples during the compression process was performed on a Type URS-70K1 apparatus with unfiltered iron x radiation. The specimens were made from single crystals of beryllium obtained by slow crystallization from the melt contained in a beryllium oxide crucible. Specimens in the form of rectangular parallelepipeds of dimensions $2 \times 2 \times 4$ mm were prepared in the usual way: electric spark cutting, polishing, chemical etching, annealing, and electrical polishing. Only samples with a relatively perfect structure were used in this study, i.e., we did not use samples containing large grains.