# ABSTRACTS

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# APM 2022
# BOOK OF ABSTRACTS

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## SYNCHROTRON X-RAY STUDY AND MICROMECHANICAL INTERPRETATION OF DISLOCATION EMISSION FROM GAS CAPSULES IN SHAPED SAPPHIRE

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The high demand for sapphire crystals derives from necessity to fabricate various products, such as high-power lasers, substrates for electronic devices, and different instruments, including tubes, rods, ribbons, etc. Methods of sapphire growth have their advantages and disadvantages depending on the application but do not eliminate the main similarity: sapphire crystals are grown from a gas-saturated melt. A common feature of growing crystals is the ability of the engulfment gas bubbles that occur at the solidification interface. The gas capsules formed in the crystal interior can have different shapes and sizes [1]. Obviously, the probability of their nucleation depends on the growth method. However, it is almost impossible to achieve complete elimination of the capsules. As a result, the transparency of sapphire in the visible light range decreases and its structural quality deteriorates. In particular, gas capsules can provoke the formation of lattice dislocations and weakly misoriented grains, which reduces the strength of the crystals.

In this work we focus on μm-sized spherical capsules and suggest a model for dislocation emission that takes into account the sizes of the spheres. Optical microscopy is commonly used for sizing. However, when performing high magnification optical microscopy, the reduced focus length is required to detect micro-inclusions, which limits the possibilities of visible light imaging to thin samples. A large thickness of sapphire articles, e.g., wafers, ribbons, rods, needles, *etc*., does not permit an accurate determination of the capsule size using a light microscope. Therefore we decided to take advantage of the properties of a 3rd-generation synchrotron radiation (SR) x-ray beam and to use an in-line phase-contrast imaging (PCI) technique [2].

Phase-contrast images are recorded on a charge-coupled device (CCD). In PCI technique, image features depend on the sample-to-CCD distance. Recording images at several distances one can determine the real size of the capsule by solving the inverse problem. The way to solve the inverse problem is computer simulation which is made using the program developed within the framework of the phase-contrast theory of three-dimensional objects [3].

X-ray Bragg diffraction imaging (topography) visualizes structural defects in sapphire crystals. As a result, by matching phase-contrast and diffraction images we have related the generation of dislocations to the capsules. Finally, the micromechanical interpretation to critical strains for the basal plane slip is provided.

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References

1. Bakholdin S I, Maslov V N, and Nosov Yu G 2014 Crystallography Reports 59 762
2. Snigirev A, Snigireva I, Kohn V, Kuznetsov S and Schelokov I 1995 Rev. Sci. Instrum. 66 5486
3. Kohn V 2021. Available online: http://xray-optics.ucoz.ru/XR/xrwp.htm

## THE CREEP CURVES MODIFICATION AFTER AGING FOR DIFFERENT PROGRAMS

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At recent decades, polymer composite materials become more widespread and developed in critical areas of engineering practice. They are used, in particular, in aircraft, rocket and automotive engineering, shipbuilding, railway transport, agricultural machinery production and construction. Advantages of these materials are high strength and stiffness, lightness, high fatigue strength, chemical inertness, heat and electrical conductivity, and others.

Because these materials are used in critical areas of engineering practice, so this makes their long-term aging and creep characteristics of paramount importance. At the same time, the physical and chemical characteristics of these materials essentially changed after long-term operation, significantly due to the aging process [1-4]. Thus, investigations of aging of these materials are much needed.

Experimental studies on alternation of natural and thermal aging and deformation aging were conducted to study the evolution of creep characteristics of carbon fiber reinforced plastics (CFRP). Specimens made of CFRP of the T26/22502/I131636 brand with a working length of 140 mm, a width of 15 mm and a thickness of 0.75-0.85 mm we investigated. The experimental creep curves after different aging programs were received.

The first series of specimens were tested on alternation of creep, natural and thermal aging and cyclic loadings. In total experiments were carried out during 4 years. At the first stages of deformation aging a hardening effect during creep by 1.5 times is occurred. Then, after additional aging the softening is observed (the creep deformation was only 1.35 times