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Keywords: lanthanide orthovanadate, bulk spiral growth, Hartman-Perdok (HP) theory

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Mechanism of formation of $Na_xV_2O_5$ bronze crystals grown from the melt by czochralski method

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Recently a new technique of manufacturing of nanoelectrical and nanomechanical devices has been offered. The method is formation of nanostructures on substrates by thermo-electrical operation of atoms or atoms complex currents in the direction probe-substrate or substrate-probe in automatic regime [1, 2]. Practical realization of such nanostructure formation technique demands to create bulk-active probes with emission-getter functions and to use scanning tunnel microscope of special construction to control the adsorption-desorption processes. The structural peculiarities of oxide vanadium bronze allow to emit interstitial atoms from channels of V-O skeleton on a substrate or, on the contrary, to remove atoms from a substrate and introduce them into the structural channels of the needle- probe. Increasing of cations content in homogeneous region does not influence on V-O skeleton, but physical-chemical properties vary non-monotonously.

The present paper demonstrates the structural-morphological peculiarities of β-$Na_{0.28}V_2O_5$ crystals growing from the melt in air and in reducing atmosphere by Czochralski method. Optical microscopy and STM images of surface relief for as-grown planes and cleavage planes as well as photometric analysis of REM images of lateral surface and spectra of reflex brightness in visible before and after vacuum annealing are given. Scanning tunnel microscopy was also used for observation of absorbtion-desorbtion processes on substrate with the help of emission-active probe ($Na_{0.33}$ V_2O_5) in tunnel regime.

It was shown that the difficulties are arising mainly from polycrystallization during growth and breakage after crystal growth. For Cz-bronze a dendritic shape is generated during the crystallization process. Surface morphology is formed of cleavage faces of the crystal. We could observe sets of nearly parallel steps on {100} planes prolonged along growth “b” axis. Thick steps were composed of two to twenty terraces. They have “V-shaped” structures which always tend to become rounded. Terraces were usually around 240nm in height. Lateral planes of such terraces were disoriented of ≈15° relatively to each other. The height of each thick step was around 1.2 μm. The terraces were usually originated from the seed. Such growth mechanism has an important role in the formation of structure imperfections. The bulk consists of two-dimensional layers in a highly crystalline and oriented form which prolong along growth direction. It revealed that oxygen was doped into the bronze ingot while it was grown in air atmosphere. Investigations of as-grown bronze $Na_xV_2O_5$ behavior at thermal treatment in vacuum also estimated the definite role of oxygen in structure formation of Cz-$Na_xV_2O_5$ bronze. X-ray phase analysis of as-grown Cz-bronze and X-ray structure analysis in temperature interval 25-320 °C were carried out to confirm phase homogeneity and thermal stability of Cz-$Na_{0.28}V_2O_5$ crystal.

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Keywords: oxide_vanadium_bronze, Czochralskii_growth, morphology

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High Quality Protein Crystal Growth under Microgravity in JAXA PCG project

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Japan Aerospace Exploration Agency High Quality Protein Crystal Growth project (JAXA PCG) had six flight opportunities from 2009 to 2012, followed by the previous JAXA-GCF, JAXA-New-GCF project. We produced various know-how of protein crystallization experiment in space in these projects.

The protein samples are transported by Russian Progress Spacecraft to the ISS in cooperation with Federal Space Agency of Russia (FSA) and are placed in the Protein Crystallization Research Facility (PCRF) in Japanese Experiment Module “Kibo” (JEM) for 2-4 months.

The experimental opportunities are provided for Japanese national project targeting the biological protein molecules to clarify diseases and life phenomenon, for JAXA strategic mission to get results through the space experiment, for technical development to crystallize membrane protein and protein-ligand complex and for international cooperation for Russian user and Asian nations such as Malaysia.

We used "Gel-Tube method", a kind of counter-diffusion method, for crystallization. In the counter-diffusion method PEG and salt are diffused into the protein solution in a capillary and increased their concentrations gradually up to those in the precipitant solution. We introduce some experiments to know optimum salt concentration for crystallization which will be helpful for reconsideration of the salt concentration in the PEG solution if crystallization fails even by the vapor-diffusion method.

We developed the method by which we estimated the effectiveness of crystallization under microgravity environment and optimized the crystallization condition in space.

We treated more than 100 proteins onboard “Kibo”. In this presentation the latest scientific results related to positive effect of microgravity environment for creating high quality crystals are introduced. Some crystals obtained in International Space Station showed the high resolution data to contribute greatly to designing new drug or new functional catalyst.

Key words: microgravity crystallization, international space station, high-resolution protein structures

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Pure $NaNO_3$ crystal growth

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