別紙様式８

研 究 主 論 文 抄 録

論文題目　　Anomalous structure change of some compounds under strong gravitational field
（強い重力場による幾つかの化合物の特異な構造変化）

熊本大学大学院自然科学研究科　複合新領域科学専攻衝撃エネルギー科学講座
（　主任指導　真下　茂　教授　）

論文提出者　　ラバヤ　バグム
（by　Rabaya Bagum）

主論文要旨

In this present research, we tried to focus on strong gravity effect. It might be clear that the some effect and mechanism of strong gravity, such as there are structure changes, composition changes and others. But, all of mechanism and phenomena has still unknown.

In the **Chapter 1**, I have discussed mechanism of strong gravity field, expected effect on the selected materials and some previous works on T. Mashimo laboratory and purpose of the present study.

In the **Chapter 2**, I have introduced about apparatus used for this study such as ultracentrifuge apparatus, Synchrotron XRD, Crystal refinement program etc.

In the **Chapter 3,** the mega-gravity field experiment was performed on an intermetallic compound of Bi-Pb system alloy (Bi_3Pb_7), and the composition and crystalline states superconducting property were studied. It was found that a visible four-layer structure with graded structure was formed from a homogeneous ε-phase Bi_sPb_7 intermetallic compound starting material under a strong gravitational field. In the 2nd 3rd layers, composition graded structures, where Pb content increased along gravity direction, were formed. In the 2nd layer, a broad XRD pattern was observed, which indicated the amorphous state. These anomalous structures are expected to influence the physical properties. I investigated the superconducting property with a scanning SQUID microscope, the preliminary result showed that no vortex state like type-I superconductor parallel to gravity was observed at the 2nd layer, while along perpendicular direction vortex was observed in the 2nd layer. The Bi-Pb system alloy is one of the first discovered superconducting alloys with high critical temperature.

In the **Chapter 4**, a twinned single phase $Y_1Ba_2Cu_3O_{7-x}$ crystal have subjected to ultracentrifugal fields (380,000 G) at temperatures of 250 °C that are low compared with the melting point of the crystal. we examined changes in structure and composition under a strong gravitational field and temperatures remarkably lower than the Y123 melting point. We observed essentially two-layers with different compositions caused by sedimentation of atoms. The layer exposed to the stronger gravitational field is composed of an Y123 phase that has a smaller unit cell volume compared with the initial sample, green, transparent, large single crystals of Y211, and a $BaCuO_2$ phase. Despite the remarkably lower temperature, compositional and structural changes in addition to decomposition were found. The unit cell volume of the Y211 phase was larger than previously indicated by synchrotron x-ray diffraction (XRD) analysis. Refinement of the Y211 structure from the XRD data also showed that these crystals are very perfect due to a very high extinction coefficient 0.7(9) $\times 10^{-6}$ and symmetrical arrangement compared with the superconducting phase Y123 crystal structure. The study provides evidence that strong gravitational fields can be applied to produce new materials at temperatures much below their melting points

In the **Chapter 5**, a noble structured rutile (TiO_2) was obtainedby strong gravitational fields (around 0.39×10^6 G , 0.018Gpa) along the c-axis direction during heat treatment (400 °C) that are low compared with the melting point of the crystal (2100°C). According to the EPMA results, it was confirmed that ultracentrifuge sample is homogeneous in composition. The c/a ratio of the tetragonal phase rutile (TiO_2) decreased in ultracentrifuge sample, which showed crystal structure more anisotropic structure. The ratios of Ti-Oa /Ti-Ob and Oa-Oa / Oa-Ob of ultracentrifuge sample approaches to 1 (0.977 and 0.9424) which attributed to isotropic state TiO_6 octahedral unit. This is against the Palling third law. As a result, newly structure material is more ionic and more isotropic than standard rutile. The Band gap increased to 4.01ev (standard: 3.88 ev) due to increase of Ti and Oa bond. Furthermore, infra-red frequency peak of Ti-O stretching shifted from 731 to 712 cm^{-1}.They were consistent with enlarge bond length of Ti-Oa, 1.9595 Å. This study provides evidence that noble structure material is produced with subtle change of crystal structure (almost isotropic TiO_6 octahedral), and the electronic structure of covalent material by strong gravity.