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Magnetic ejection and rotation of diamagnetic minerals induced by a permanent magnet in microgravity

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Translation and rotation and of solid substance are classical magnetic motions that are publically recognized to occur on spontaneous magnetic moment; they are not presently believed to occur on ordinary diamagnetic minerals. In the present report, basic properties of free magnetic motions caused by diamagnetic magnetization are studied by microgravity experiments (1). For this purpose, field-induced translations were newly observed for various diamagnetic minerals, namely forsterite, calcite, alfa-quartz, gold, diamond and graphite; these mineral have different susceptibility values. Significances to detect diamagnetic susceptibility and its anisotropy of a single grain is discussed based on the obtained data.
Diamagnetic magnetization and its anisotropy of an oxide mineral derive mainly from three-dimensional distribution of localized electrons. For organic materials, origin of magnetization of where explained in terms of a molecular-orbital method by Pauling. Consistency of this method was examined by comparing theoretical and experimental magnetization (2). The investigation was not performed on oxide crystals partly because the experimental values were not reported for most of the materials. It was difficult to detect the small anisotropy by the conventional methods. Further improvement of sensitivity using microgravity condition was necessary in order to understand the overall relationship between electron distribution and anisotropy of susceptibility.
Dynamic motion has been recently considered for a diamagnetic crystal which is affected only by static magnetic field(1); the crystal is isolated in defused medium and effect of viscosity and gravity are assumed to be negligibly small. Firstly, a particle placed in a field gradient, which decreases monotonously show translation even though the material was free of magnetic ions. The translation was previously observed on corundum single-crystal that was released in a diffused microgravity condition(1), and the measured acceleration was proportional to B(dB/dx) as expected. A susceptibility value determined form a linear correlation between velocity and B(dB/dx) agreed fairly well with the published value of corundum (2). It was deduced from the above relation that kinetic energy of a particle at an arbitrary position uniquely depends on the magnetic potential energy of particle. Accordingly, velocity of particle is uniquely determined by susceptibility of sample in a given field distribution; here initial velocity is assumed to be negligibly small..
Identification and characterization of a single mineral grain can be carried out from the susceptibility and anisotropy obtained by the above two motions. Identification is possible because each mineral has different intrinsic susceptibility and anisotropy, as is compiled in a data book of published data (2). The susceptibility observed in the present work ranged between 2x10E-7 and 5x10E-6 emu/g; almost all the published values of diamagnetic mineral distribute within this range (2). Hence identification is possible for natural material in general. It is deduced from the motional equations that measurement can be realized on limitlessly small sample in principle without districting the sample, since the method do not require sample holder and mass measurement; these factors are inevitable in conventional methods. Precise susceptibility data of individual particle is expected to provide supplemental information on the distortion of crystal structure that is considered to occur on small particles; the degree of distortion is expected to increase as particle

size decreases.

References (1) K. Hisayoshi, S. Kanou and C. Uyeda: J. Phys. : Conf. Ser., in press. (2) R. Guputa: Landort Bornstein New Series (1983) 445. (3) T.Iwakami and M.Nokura: J.Jpn.Soc.Microgravity Appl. 23 (2006) 186. (4) C.Uyeda submitted.

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