Separation of diamagnetic & paramagnetic particles realized in μg condition using a field distribution produced by a small niobium magnetic circuit

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A mixture of many paramagnetic and diamagnetic particles was completely separated into ensembles of different materials by translating them in an area of magnetic field that monotonically dereased in one direction (i.e. *x*-axis in Fig.1). The field distribution was produced by a small magnetic-circuit composed of two NdFeB plates. The particles were released at a position of $x = x_0$ with negligible initial velocity; field intesity at this position was B_0. Terminal velocity v_T of the ensambles in the area of B~0 was 1.3 cm/s in magnecia, which increased to 9.1 cm/s in graphite [1][2]. These experimental values were consistent with the calculated values based on a simple conversion rule between a field-induced potential $-½m\chi_{DIA}B_0^2$ and a kinetic energy $½mv_T^2$ assumed in the particles; m and χ_{DIA} denote mass and diamagnetic susceptibility (per unit mass) of the particles, respectively. The material separation was realized because v_T was independnet to m, the relation is deduced from the conservation rule[1][3]. The χ_{DIA} values of the above ensambles ranged from -2.6×10^{-7} to -5×10^{-6} emu/g, which nearly overlaped with the range of the published values [4], and it may be concluded that the method has the potential to separate existing solid materials. A short drop shaft (length~1.8m) was introduced to produce the μg condition, and the aparatus to observe the particle motion was designed to be installed in a small drop box (volume:~2×10^4cm^3) [3]. In order to apply the mothod of separation in practical purposes, it is essential to confirm the practicabiiity of the conservation rule. Therefore, in the present report, the χ_{DIA} v.s. m relationships are examined at different experimental conditions. The proposed method has significance that can be comparable to that of the chromatography technique populary used to extract organic molecule; extraction of novel materials in hrogeneous sample has frequently induced important discoveries.

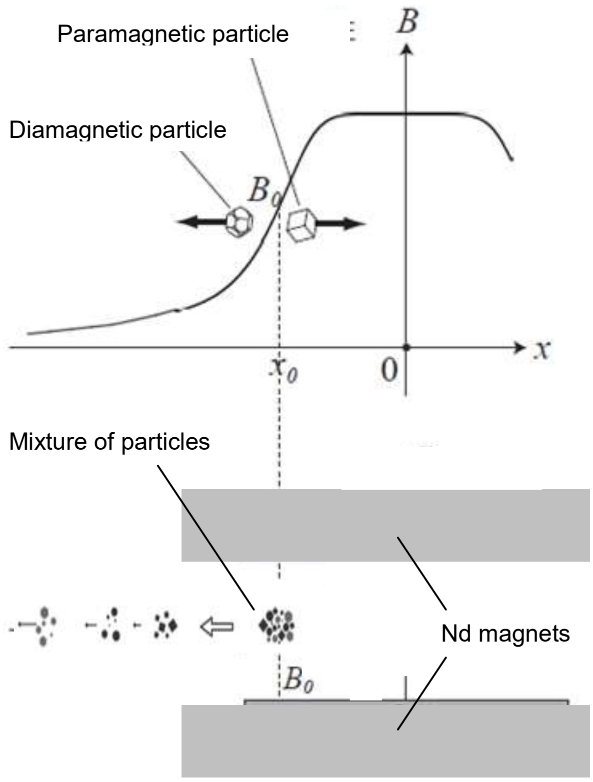

Figure 1. An illustration showing the principle of magnetic separation of weak magnetic particles using a microgravity condition. The terminal velocity of particles in the *B*~0 area is independent to particle mass, which realizes the material separation; this property is deduced form an energy conservation rule described in text [1][3].

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