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Magneto-Archimedes levitation of metals by optimized ferromagnetic cylinder arrays in magnetic fields

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We have studied magnetic levitation properties for metals by magneto-Archimedes effect under a high magnetic field gradient. Magneto-Archimedes effect is a phenomenon that materials levitate at a particular position in a paramagnetic medium by applying magnetic field gradient due to the difference of magnetic susceptibility and density between the medium and the materials. In order to enhance the magnetic force factor BdB/dz in a vertical direction, a ferromagnetic cylinder and an array of the cylinders were set into the room temperature bore of a 10 T superconducting magnet. We optimized the shape and the arrangement of the ferromagnetic cylinders to increase the magnetic force. The maximum BdB/dz achieved the high value of over -1600 T^2/m which was about 4 times larger than that without ferromagnetic materials. However, the problem remains that $BdBdz$ only increases just above the ferromagnetic cylinder. We succeeded in solving the problem by using the ferromagnetic cylinder array. The magnetic levitation properties for several kinds of metals in manganese chloride aqueous solution as a paramagnetic medium were studied. Each metal levitated at different height in relatively low magnetic fields. The ferromagnetic cylinder array made the metal grains and powders levitate uniformly in a horizontal direction. That proposes a new magnetic separator for valuable resource recovery from solid mixture in relatively low magnetic fields.

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