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ELECTROMAGNETIC FIELDS TO REGULATE MATERIAL DEFECTS, BATTERIES, AND PROPERTIES

Abstract

Research investigates electromagnetic interactions of material defects, exchange energy, domain wall (DW) spin gradient and movement, and electron scattering in solid materials and batteries. The effects of the near null magnetic field (NNMF) have been studied on cell membrane and ions, however, the effects of lack of electromagnetic (EM) fields on crystal lattice dynamics are not well understood. Effects of Pulsed Electromagnetic Fields (PEMF) and magnetization direction around dislocations and defects are discussed. Isolating effects of EM fields, radiation, vacancies on crystal lattice, electron spin alignment can further be a challenge. As EM fields influence charged particles, pulsed electromagnetic fields (PEMF) provide good structural improvements and are promising for material processing, reducing Gibbs free energy for nucleation.With metallic materials aligned by strong magnetic field, preferred orientation or alignment on a crystalline material is effective to control crystal and grain orientation. (Ming,2019) After 20 sec of 153mT PEMF, 10um grain rotated 31 deg with complete rotation in 45 sec and complete rotation in 186sec for a magnetic flux density of 50 mT (5E4 uT). As PEMF generates lorentz force in internal microcells, 20increased tensile strength of the -Al material increased by almost 20 MPa. (Bai, et al,2020) The primary interaction between dislocations and the direction of magnetization is due to the magnetoelastic (magnetostrictive) effect. If a small magnetic field is applied, it is relatively easy to rotate the magnetization in the environment of the dislocations. (Seege,1966) . Moreover, the lattice constant (spacing between atoms), the interplanar spacing, and microstrain increase with the duty cycle of PEMF, especially for the (111) and (200) crystal planes.(Bai,et al,2020) S (spin) and L(orbital) couple together and form a total angular momentum (J) in low EM fields and B is Bohr magneton with preferential growth of more ferromagnetic/diamagnetic crystals in orientation of the EM field.With higher electron skew scattering, side jumps, and delocalized electrons from point and line defects, a low cost PEMF prototype is later designed, built, and tested with various materials, batteries, and solar cells with and without defects. In approaching material's magnetization saturation (kA/m), coercivity and increasing electron hole and ion displacement, low applied electromagnetic fields (H intensity, vectors, duty cycle) are modeled toward end use applications and environments such as in the Near Null Magnetic Field.Low power EM fields hold potential to reduce defect density and extend battery lifespan by up to 50%.