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X-Ray Fluorescence and X-Ray Diffraction Analysis on Discrete Element Modeling of Nano Powder Metallurgy Processes in Optimal Container Design

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Editor's Note

It was the invention of fire, which has given a new shape in the development of humankind. Use of fire to modify metallic structure assisted to have desired shape of raw metal. The necessity of metallic weapon secured the prehistoric life of ancient human. Relic evidence highlighted the fact that, the use of metalwork has an illustrious history, which started with Copper (9000 BC) then different other metals and alloys came into use. With the innovative mind of human being, the use of metal was not limited only in weapon making; different utensils and shelter equipment also got the metallic touch. This feat made them a regional superpower for years to come. Thus, at step, the methodology of metallurgy underwent multiple refinements. Powder Metallurgy (PM) is one such refinement which is concerned with production of metals in their powder form and molding them into various shapes. This form of metallurgy was incorporated into the echelon of metallurgical techniques at around 3000 BC and has seen numerous advancements since then. However, research and study on Metallurgy and Mining is a timely need of present era to provide and meet the global need of metal. Journal of Powder Metallurgy & Mining is devoted to accumulate the information about recent progress in metallurgic science. The recent release of Journal of Powder Metallurgy & Mining presents some interesting findings in the metallurgic field. Liss et al. investigated the history of metal production at Khirbat al–Jariya (KAJ), Jordan and found that the Iron Age populations were aware of the "self–fluxing" property of the local ores for smelting, hints towards a technological sound populace [1]. Shen et al. identified that increasing the SiC particle content results in improved tensile strength and yield strength of the Al–Mg–Cu–Sn matrix composites [2]. Algan et al. observed that addition of borax powder enhances the wear resistance of brake pad pads whereas addition of metallic fibers improves the coefficient of friction [3]. Rani et al. prepared thin films of CdSe:Zn using Electron Beam (EB) evaporation technique [4]. Amiour et al. investigated the microstructure and the shape memory related properties of Cu–Zn–Al alloys [5]. Their results revealed that any modification in the composition of the alloy led to the generation of new phases. Sonmez et al. observed that Mechanical Alloying (MA) in addition to refining the powder of Tungsten (W) composites also increases the dislocations in the powder crystals resulting in plasticity of the alloy, which is eminently desirable [6].

The Faynan region of Southern Jordan, home to the largest Copper deposits in Southern Levant, was at the epicenter of an industrial revolution during the Iron Age (1200–500 BC). To this day, ancient smelting sites populated with huge mounds of industrial slag can be found in Fanyan. One such site is Khirbat al–Jariya (KAJ). Liss et al. investigated the history of metal production at KAJ by excavating a slag mound [1]. The authors sampled geo–referenced slag specimens corresponding to the various strata of the dig and subjected it to X–Ray Fluorescence (XRF) analysis. The authors observed that the older samples were rich in Copper, whereas the newer ones had approximately 70% less Copper content indicating a shift towards more advanced and ergonomic metallurgical techniques. Further, it was revealed that all the sample ores were "self–fluxing" as they were rich in manganese. The fact that, the Iron Age populations of Faynan were aware of the "self–fluxing" properties of these ores and specifically chose them for smelting, hints towards a technologically sound populace. The properties and microstructure of alloys can be regulated by micro–alloying with Silicon or Copper. SiC or CuC reinforced alloys are usually prepared by casting methods such as gravity casting, infiltration casting, transfer molding etc. The downside of this method is the heterogeneous distribution of SiC particles. The Powder Metallurgy (PM) method is an alternate method of preparing SiC particle reinforced Al–Mg–based alloys. The properties and microstructure of SiC reinforced Powder Metallurgy (PM) Al–Mg–based alloys are influenced by the SiC particle size and volume fraction, the sintering process used, and the matrix alloy composition. Shen et al. studied the influence of solution treatment temperature and SiC particle content on the mechanical properties, the corrosive behavior, and microstructure of the alloys using scanning electron microscopy [2]. The authors observed that increasing the SiC particle content results in improved tensile strength and yield strength of the Al–Mg–Cu–Sn matrix composites. The Vickers hardness is affected by solution treatment temperature. Both the SiC content and the solution treatment temperature affect the corrosion behaviour of Al–Mg–Cu–Sn alloys.

As brake pads are generally used to decelerate or apply brakes on vehicles, they are subject to a significant amount of physical strain. Braking–related friction and wear behaviour depend on the driving conditions, composition of the brake pads, and the friction film interface between the rotor and the friction material. Therefore, a significant number of experimental studies aimed at streamlining the braking process such as stabilization of friction, lowering of noise and vibration, are currently going on. The correct selection of brake pad components is essential and is one of the ways of bringing about these changes. Algan et al. investigated the effect of Copper or Bronze fibers or borax powders on friction and wear characteristic of brake pads [3]. The authors observed that addition of borax powder enhances the wear resistance of brake pad pads whereas addition of metallic fibers improved the coefficient of friction.

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CdSe:Zn films are of particular interest for developing novel opto–electronic devices. Rani et al. prepared thin films of CdSe:Zn using Electron Beam (EB) evaporation technique, throughout the procedure, the concentration of Zinc varied, 10%, 20%, and 30%, respectively [4]. The authors studied the microstructure of these films using X–Ray Diffraction (XRD) analysis. Optical studies revealed the direct band gap nature of all films with the band gap values varying from 1.90 eV to 2.42 eV, thereby confirming the formation of solid solution between ZnSe and CdSe compounds whose lattice modification is effected by the incorporation of Zinc. The surface morphology analysis revealed fine granular grain formation uniformly distributed over the entire surface. Cu–based Shape Memory Alloys (SMAs) are very promising because of their low cost and high recovery force. In this issue, Amiour et al. have investigated the microstructure and the shape memory related properties of Cu–Zn–Al alloys [5]. The results revealed that any modification in the composition of the alloy led to the generation of new phases. Therefore, mechanical properties of various alloys are strongly affected by the microstructure.

Tungsten (W) is endowed with a high melting point, low thermal expansion coefficient, high elastic modulus, high thermal shock resistance, and high stiffness; therefore, Tungsten (W) based alloys are prime candidates for high temperature applications. As the melting point of Tungsten (W) is very high, 3422°C which is the highest among metals, and second highest among all elements; its fabrication is extremely difficult. Therefore, a process called as Powder Metallurgy (PM) is employed to fabricate Tungsten (W) in a non–molten state. Mechanical Alloying (MA) techniques are generally used in Powder Metallurgy (PM) for attaining a homogeneous fine grained matrix which is thermally stable and heat–resistant. Sonmez et al. studied the morphological properties of mechanically alloyed Tungsten (W) composites and investigated the effect of Titanium Carbide (TiC) addition on the same [6]. The authors observed that Mechanical Alloying (MA) in addition to refining the composite powder also increases the dislocations in the powder crystals resulting in plasticity of the alloy, which is eminently desirable.

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