Joint Event

36th International Conference on
Nanomaterials and Nanotechnology

24th World Congress on
Materials Science and Engineering

February 15-16, 2023

Webinar

Nanomaterials for agriculture

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Agriculture works in open system, where control and fate of applied nano-materials are uncertain. This calls for redefining nanotechnology and enforcement of rigorous ethics at all stages from fabrication to application of nanomaterial in agriculture. The virtue of clean eco-system free from lethal biotic and abiotic substances and sanitation, interdependence of life forms and safety of food are the lessons we relearnt during COVID pandemic. They are especially indispensable in pedosphere-biosphere-atmosphere domains. Author primarily focused on fertilizers because fertilizer resources are depleting at a fast pace, their low use efficiency is detrimental to environment and conventional fertilizers are made up of salts; one component of which is plant-nutrient ion(s), while counter component is either not very useful or, toxic leading to irretrievable impairment to soils and food-quality threating human and animal health. Some fertilizers like phosphates contain high amounts of heavy metals (e.g., Cd, Cr, Pb, Sb, V, Zn and Cu) and radioactive elements (e.g., U and Th) and as a consequence they get accumulated in soils causing irreversible damage to the ecosystems. Author attempted to address the above stated issues by: (1) obtaining heavy metal and radionucleotide free phosphate minerals through novel beneficiation process of low-grade rock phosphate, (2) assembling exclusive phosphate ion (PO43−) and Zn2+ ions in clay mineral receptacles and (3) innovate farmer-centric method for fabricating plant nutrient supplier nanomaterials. Segregation of P-containing minerals devoid of toxic materials from Phosphate Rock (PR) ore was based on a set of physical non-destructive process that involved physical breakdown of large rock materials into smaller (sand size) parts accompanied by screening, followed by sink-or-float separation of heavy-metal free phosphorus-minerals from the sand size ore using desired specific gravity liquid that do not dissolve ore-materials. Phosphate ion was extracted by dissolving P-minerals by rhizospheric acids. Novel nano-phosphorous products were manufactured by intercalating phosphate ion (PO43−) in kaolin clay mineral and novel nano-Zn in montmorillonite. The nanoproducts, when applied to soil would release either phosphate ions (PO43−), or get converted to hydrogen phosphate ions (HPO42−) or dihydrogen phosphate ions (H2PO4−) or Zn2+ ions as the case may be. Fields of agriculture consume inputs like fertilizer in huge quantities and in repetitive manner in every growing season. Novel nanomaterials might open up gigantic market opportunity.

Biography

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Received: February 10, 2023; **Accepted**: February 12, 2023; **Published**: February 15, 2023