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Synthesis and Optimization of Bio Metal-Organic Framework with Permanent Porosity

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Abstract : Metal-organic frameworks (MOFs) with their specific properties and the possibility of tuning the structure represent excellent candidates for use in the biomedical field. Their advantage lies in large pore surfaces and volumes, as well as the possibility of using bio-friendly or bioactive constituents. So-called bioMOFs are representatives of MOFs, which are constructed from at least one biomolecule (metal, a small bioactive molecule in metal clusters and/or linker) and are intended for bio-application (usually in the field of medicine; most commonly drug delivery). When designing a bioMOF for biomedical applications, we should adhere to some guidelines for an improved toxicological profile of the material. Such as (i) choosing an endogenous/nontoxic metal, (ii) GRAS (generally recognized as safe) linker, and (iii) nontoxic solvents. Design and synthesis of bioNICS-1 (bioMOF of National Institute of Chemistry Slovenia – 1) consider all these guidelines. Zinc (Zn) was chosen as an endogenous metal with an agreeable recommended daily intake (RDI) and LD50 value, and ascorbic acid (Vitamin C) was chosen as a GRAS and active linker. With these building blocks, we have synthesized a bioNICS-1 material. The synthesis was done in ethanol using a solvothermal method. The synthesis protocol was further optimized in three separate ways. Optimization of (i) synthesis parameters to improve the yield of the synthesis, (ii) input reactant ratio and addition of specific modulators for production of larger crystals, and (iii) differing of the heating source (conventional, microwave and ultrasound) to produce nano-crystals. With optimization strategies, the synthesis yield was increased. Larger crystals were prepared for structural analysis with the use of a proper species and amount of modulator. Synthesis protocol was adjusted to different heating sources, resulting in the production of nano-crystals of bioNICS-1 material. BioNICS-1 was further activated in ethanol and structurally characterized, resolving the crystal structure of new material.

Keywords : ascorbic acid, bioMOF, MOF, optimization, synthesis, zinc ascorbate
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