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Mechanochemical synthesis: Novel materials for magnetic cooling applications

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The presentation addresses the mechanochemical approach to solid-state synthesis, which proved to be indispensable for the solvent-free preparation of a great variety of molecular, ionic and metallic solid materials. The talk specifically focuses on the solid-state synthesis of rare earth-based metal organic frameworks (MOFs), which have a potential for becoming materials of choice for low temperature magnetocaloric systems that are under development at CaloriCool™. CaloriCool™ is a newly established research consortium, which discovers, develops and deploys materials for magneto- electro- and elastocaloric cooling. It is a part of the DOE's energy materials network (EMN) designed to accelerate innovation around the clean energy industries by addressing pressing materials challenges ranging from early development to manufacturing. In the course of our research, we showed that the mechanochemical approach can be successfully applied to the preparation of MIL-78-type metal organic frameworks. Contrary to the previous reports, the presence of a liquid (liquid assisted grinding) is not essential for the process. Thus obtained Gd-, Tb- and Dy- based MOFs showed short range magnetic order below 20 K; no long range order was observed down to 2 K. The magnetocaloric effect of Gd-based material was found to be comparable to the best known cryogenic refrigerants. Our further investigations revealed that the mechanochemical methodology can be extended onto other rare earth-based hybrid organic-inorganic materials with substantial magnetocaloric effect at cryogenic temperatures.

Biography

V P Balema has his expertise in new material development in academic and industrial environment. The main focus of his research during the last decade has been on the energy conversion and storage materials, and non-conventional materials preparation techniques, including solvent-free mechanochemistry. For a decade, between 2006 and 2016, he was directing Hard Materials Market Segment and Materials Science R&D at Sigma-Aldrich Co. In 2016, he joined the Ames Laboratory and led research consortium CaloriCool™ where he directs the materials development group. He has served as a reviewer for the US Department of Energy, NSF, US Civilian Research and Development Foundation (CRDF), ACS Petroleum Research Fund and a variety of peer reviewed scientific journals. He has also acted as the Section Chair at the annual MRS meetings and other conferences.

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