ABSTRACT

High Pressure as a Unique Tool for the Exploration of Solid State: The Case of Quadruple Perovskite Manganites

F. Mezzadri1,2, E. Gilioli1, D. Delmonte1, A. Gauzzi3, G. Calestani,2 M. Marezio1

1IMEM-CNR, Parco Area delle Scienze 37/A, Parma, Italy
2SCVSA Department, University of Parma, Parco Area delle Scienze 17/A, Parma, Italy
3IMPMC, Sorbonne Université, CNRS, MNHN, 4 place Jussieu, 75005 Paris, France

When pressure reaches levels comparable to the energy of chemical bonds, complex phase transitions can be induced, allowing to investigate unexplored features of inorganic compounds. High pressure (HP) favors dense structures with high coordination numbers, oxidation states, and low crystal symmetries. When applied during a solid-state synthesis carried out at high temperatures (HT), HP can lead to the formation of metastable phases. Laboratory facilities can achieve pressures up to 25 GPa and temperatures exceeding 2000 K, however complex set-ups are often needed, especially when isostatic conditions are crucial. Among the classes of compounds successfully synthesized under HP/HT conditions, perovskites play a central role. Their intrinsic tolerance to chemical substitutions, further enhanced by HP synthesis, has yielded hundreds of compositions with distinct structural and physical properties. Quadruple perovskites, with the general formula AA’3B4O12, are highly correlated electron systems featuring distorted frameworks that often require HP to stabilize. When the A’ and B sites are occupied by Mn, the charge, ionic radius and electronic configuration of the A atoms tunes a wide range of phenomena, including charge, orbital, and spin orders, giving rise to unique electrical, magnetic, and multifunctional properties. Quadruple perovskite manganites with A=Na, Ca, La, or Bi will be presented [1-4], focusing on the relations between physical properties and their peculiar HP-induced crystal structures.

[1] A. Prodi, E. Gilioli, A. Gauzzi, F. Licci, M. Marezio, F. Bolzoni, Q. Huang, A. Santoro, J.W. Lynn, Nature Mat., 3(1), 48 (2004).
[2] G. Zhang, S. Dong, Z. Yan, Y. Guo, Q. Zhang, S. Yunoki, E. Dagotto, J.-M. Liu, Phys. Rev. B, 84, 174413 (2011).
[3] A. Prodi, E. Gilioli, R. Cabassi, F. Bolzoni, F. Licci, Q. Huang, J.W. Lynn, M. Affronte, A. Gauzzi, M. Marezio, Phys. Rev. B, 79, 085105 (2009).
[4] F. Mezzadri, G. Calestani, M. Calicchio, E. Gilioli, F. Bolzoni, R. Cabassi, M. Marezio, A. Migliori, Phys. Rev. B, 79, 100106(R) (2009).