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Rational design of functional materials: A chemist's approach

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4

New functional materials can be designed by interplay of synthesis and crystallographic structure. Unconventional synthetic routes play an important role in this direction as many of these new materials are metastable and hence it is not possible to prepare them by conventional synthesis methods. Of late, the focus of research has been shifted to multi-functional materials i.e., the materials which can possess two or more than two synergistic or antagonistic functionalities. The synthesis of such materials has been a challenge and also an opportunity to chemists. We have prepared a number of new functional materials guided by crystallographic approach coupled with novel synthesis protocols. Some typical materials which will be discussed in this talk are $La_{1-x}Ce_xCrO_3$, $Pr_{1-x}Ce_xScO_3$ (materials with tunable band gap and magnetic properties), $CeScO_3$ (with unusual reversible conversion to fluorite lattice), $Gd_{1-x}Y_xInO_3$, $GdSc_{1-x}In_xO_3$, $YIn_{1-x}Fe_xO_3$ (tunable dielectrics) and several lead free relaxor materials. Perovskite and fluorite-type materials with trivalent Ce^{3+} were successfully prepared from suitable precursor powders by a controlled heating under low p_{O2}. Several interesting pyrochlore based oxygen storage materials, viz. $Ce_2Zr_2O_{7+x}$ (x = 0.0 to 1.0), $Gd_{2-x}Ce_xZr_2O_7$ and $Gd_{2-x}Ce_xZr_{2-x}Al_xO_7$ (x = 0.0 to 2.0) have been prepared, which have shown interesting redox catalysis. The simple concepts like r_A/r_B ratio of $A_2B_2O_7$ pyrochlores could be used to tailor the properties like ionic conductivity, dielectric and photocatalytic behavior. Several new hybrid materials were also prepared, such as $BaTiO_3$-Co, Fe_3O_4-PVDF and Ag@R6G, which showed interesting functional properties. The major focus of this talk will be on the role of synthesis, novel properties exhibited by these functional materials, and their crystallographic correlation.

Some of our representative publications in the field of functional materials

Advanced Materials 20 (2008)1348 ;
Chem. Mater. 21 (2009) 5848 ;
Inorg. Chem. 49 (2010) 10415 ;
Inorg. Chem. 49 (2010) 1152 ;
Chem. Mater. 24 (2012) 2186 ;
Nano Letters 12 (2012) 3025 ;
J. Phys. Chem. C 117 (2013) 10929 ;
J. Mater. Chem. C, 1 (2013) 3710 ;
Inorg. Chem. 52 (2013) 7873 ;
J. Phys. Chem. C 118 (2014) 20819 ;
Inorg. Chem. 58 (2019) 4480

Inorg. Chem. 53 (2014) 10101
Dalton Trans. 44 (2015) 16929
Dalton Trans. 45 (2016) 980
Dalton Trans. 44 (2015) 16929
Inorg. Chem. 55 (2016) 1179
Inorg. Chem. 56 (2017) 8363
Inorg. Chem. 56 (2017) 3335
Dalton Trans. 47 (2018) 6787
Inorg. Chem. 57 (2018) 6973
Inorg. Chem. 57 (2018) 2157

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Career prospects in chemistry

430

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Chemistry is an incredibly captivating field of study. In simplest form, it is a way to understand matter and the changes that take place within the matter at atomic and molecular level. Chemistry is both a central science and an enabling science that is ever expanding into biology and material science. It plays a significant role in promoting the well-being of nation by conquering diseases, solving energy and environmental problems, providing the discoveries that lead to new industries and developing new materials for national defense. In this talk, we will see how chemistry plays a significant role in academia, industry, and public life.

The talk will begin with an attempt to answer a question "why it is important to study and make career in chemistry", what are the important discoveries in chemistry that changed the world and relevance of chemistry in modern times. For students, the talk will raise a question and tries to understand that who should pursue career in chemistry and what are the future prospects in this field of science. Before coming to conclusion, the talk will also emphasize on the challenges that a chemist has a potential to solve and in this direction, it will make a sincere attempt to provide an insight about the key areas of research having significance in current scenario.