

*Pyrophosphate family of polyanionic cathodes towards safe rechargeable batteries*Ritambhara Gond¹, Prabeer Barpanda¹¹Mrc, Indian Institute Of Science, Bangalore, India

E-mail: ritugond@gmail.com

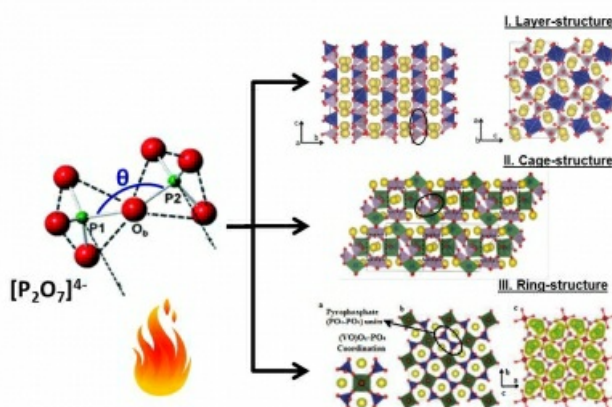
Ever-growing demand of energy has enlighten the importance of electrical energy storage, which basically includes stationary as well as mobile energy storage. Li-ion and Na-ion batteries are building up in our landfills, which provides impetus to develop efficient, less hazardous and safer electrode materials for future rechargeable batteries. The first commercialized battery by Sony (circa 1991), LiCoO₂, was based on Co transition metal delivering 0.5 Li per formula unit. LiCoO₂ consists of layers of Li that lie between slabs of CoO₆ octahedra assuming R-3m symmetry. Following various oxide cathode materials such as LiMn₂O₄ and LiNi_{1/3}Mn_{1/3}Co_{1/3}O₂ have seen successful commercialization. In early 2000s, LiFePO₄ battery revolutionised the battery industries. Since the discovery of triphylite LiFePO₄ in 1997, it has encouraged material chemists to design and develop a variety of polyanionic based cathodes owing to their robust framework, chemical/ thermal stability, tunable redox potential and desirable electrochemical performance.

Polyanionic cathodes with multiple phosphate units have been widely explored for the Li-ion and Na-ion battery. In the race of developing novel and safer cathode, pyrophosphate family of compounds has rekindled scientific attention. Pyrophosphate chemistry have been studied extensively in crystallography and used in applications targeting at catalysts, molecular sieves and ionic conductors catalysis. The present work attempts to showcase 'alkali metal pyrophosphates' family of compounds (A₂TMP₂O₇; A = Li/ Na/ K, TM = 3d metals) as next generation cathode materials. Pyrophosphate compounds offer a robust three-dimensional P₂O₇⁴⁻ framework with multiple sites for alkali ions and existence of polymorphism in such compounds. Origin of polymorphism is the reason why it has attracted crystallographers after its first report by F. d'Yvoire in 1962 focusing on KAlP₂O₇. Polymorphism arises due to the different angular orientation between the two phosphate units. Pyrophosphate class of compounds caught the attention of battery community when Goodenough's group first showed the electrochemical properties of LiFeP₂O₇ among host of other Fe-redox based compounds. Since then, suites of pyrophosphate compounds have been tested for secondary battery applications. The rich structural diversity and polymorphism leads to wide potential window of operation (ca. 2.1 to 4.9 V), having the possibility to design both cathodes at high voltages as well as anodes at low voltages. The current work will summarise recent findings in 'pyrophosphate' class of battery materials capable of reversible insertion of Li⁺, Na⁺ and K⁺ ions.

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Keywords: [Batteries](#), [Pyrophosphates](#), [Polymorphism](#)