

# Magnetoelectric and multiferroic crystals of the clinopyroxene family

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Crystals of the large family of pyroxenes show a general composition  $AMT_2O_6$  with  $A$  = monovalent or divalent cations,  $M$  = divalent or trivalent cations,  $T$  = mainly Si or Ge. The characteristic features of the pyroxene structures are chains of edge-sharing  $[MO_6]$  octahedra which are linked by chains of tetrahedral  $[TO_4]$  groups. Particularly for  $M = 3d^n$  transition metals the structural arrangement offers the possibility for competing magnetic interactions that, together with e.g. strong magnetoelastic coupling, are known to favour multiferroicity. In the series of monoclinic (clino-)pyroxenes the structural arrangement can be subtly modified by chemical substitutions on all the positions  $T$ ,  $M$  and  $A$ , leading to small atomic displacements (space group  $C2/c$  or  $P2_1/c$ ) and different spins and magnetic exchange constants. Indeed, the clinopyroxenes  $LiCrSi_2O_6$  and  $LiFeSi_2O_6$  turned out to be linear magnetoelectrics and multiferric behaviour was found for crystals of the mineral aegirine ( $NaFeSi_2O_6$ ) [1], while e.g.  $NaTiSi_2O_6$  is known as a spin- $1/2$  1D magnet with a spin-Peierls-like transition [2, 3]. However, a bottleneck in the detailed study of pyroxenes is the very limited availability of high quality crystals of sufficient size, and considerable effort to solve and improve strategies and methods of crystal growth are in progress. In the talk materials aspects of the clinopyroxenes with an emphasis on crystal chemistry and crystal growth, together with a survey of low-temperature structures is given.

## References:

- [1] S. Jodlauk, P. Becker, J.A. Mydosh, D.I. Khomskii, T. Lorenz, S.V. Streltsov, D.C. Hezel, and L. Bohatý, *J. Phys.: Cond. Matt.* **19** (2007) 432201.
- [2] M. Isobe, E. Ninomiya, A.N. Vasil'ev, and Y. Ueda, *J. Phys. Soc. Jpn.* **71** (2002) 1423.
- [3] P.J. Baker, S.J. Blundell, F.L. Pratt, T. Lancaster, M.L. Brooks, W. Hayes, M. Isobe, Y. Ueda, M. Hoinkis, M. Sing, M. Klemm, S. Horn, and R. Claessen, *Phys. Rev. B* **75** (2007) 094404.