Crystal and magnetic structures of the high pressure $RMnMnTaO_6$ (R = Rare earth) double (double) perovskites

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Perovskites ABO_3 are of great interest due to their large variety of electronic and magnetic properties. Their compositions can be modified to induce different cation orderings giving double perovskites $AA'B_2O_6$ or $A_2BB'O_6$, and even more complex double double perovskites ($AA'BB'O_6$) [1]. Recently, by using high-pressure and high-temperature (HPHT) techniques, we reported a new type of double double perovskite derivatives (DDPv) where columnar ordering at A-site and rock-salt ordering at B site are combined [2]. These crystallise with space group $P4_2/n$ and two families have been established; those with R (= rare earth) cations at A sites in $RMnMnSbO_6$ [2]; and those with Ca e.g. $CaMnMReO_6$ (M = Mn, Fe) [3].

We have successfully synthesised a new R-based series of HPHT perovskites, $RMnMnTaO_6$. Large R cations (R = La-Sm) result in a DDPv structure with space group $P4_2/n$; whereas a disordered A-site DPv structure has been observed for the smaller R =Eu-Y, with space group $P2_1/n$. By increasing the temperature, a structural transition from DDPv to DPv was observed for the very first time (**Fig. 1**), confirming the structural phase boundary for the $RMnMnTaO_6$.

Magnetic measurements show a ferrimagnetic ordering for the DDPv and a ferromagnetic ordering for the DPv. Two magnetic transitions with spin reorientation have been found for the DDPv Nd-compound. All information above indicates a very rich structural and magnetic behaviour for the $RMnMnTaO_6$ family.

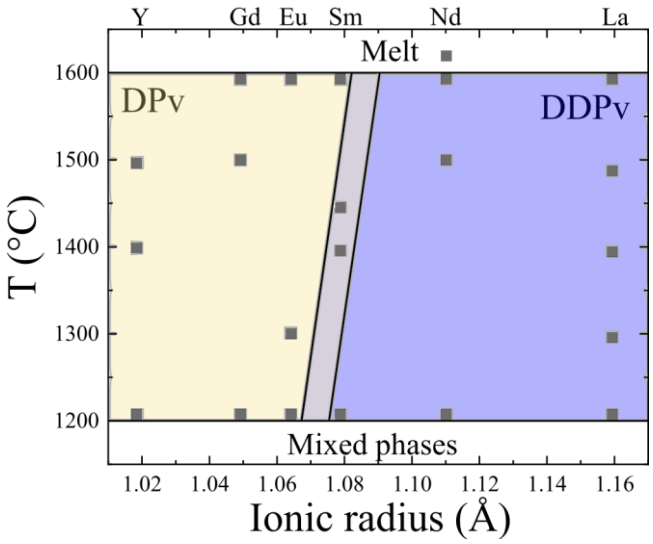

Figure 1. Phase diagram for $RMnMnTaO_6$ showing the boundary between DDPvs and DPvs. The grey region refers to a mixture of DDPvs and DPvs.

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