Synthesis of molecular phosphonates of group III elements

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The general procedures for preparation of transition metal phosphonates involve hydrothermal synthesis. Common traits shared by hydrothermally prepared metal phosphonates are layered 2D structures and a low solubility in a wide range of solvents. On the other hand, phosphonates produced by a simple salt metathesis in aprotic organic solvents, such as pyridine, can form products with very different molecular cluster geometries. A series of reactions of $ScCl_3$, YCl_3 and $LaCl_3$ with *tert*-butyl, phenyl and vinyl phosphonic acids have been performed in dry pyridine. Obtained products have been studied by ^{31}P NMR spectroscopy and by single-crystal XRD analysis. Three products have been isolated and structurally characterized using SCXRD. From the the reactions of *tert*-butyl phosphonic acid with yttrium(III) and La(III) it is $[\mu_3\text{-}^tBuP(O)_3]_4(YClpy_2)_2(YCl_2pyH)_2$ in pseudo-cubane geometry with $[Hpy]_3[YCl_6]\cdot 2py$ as a byproduct and $La_4[\mu_6\text{-}^tBuP(O)_3]_2[\mu_4\text{-}^tBuPO_2(OH)]_2(\mu_2\text{-}Cl)_2Cl_8(Hpy)_6$ with bridged-square geometry. Moreover, such molecular products still exhibit reasonable solubility in organic solvents, such as pyridine and DMSO.