Competing magnetic states and magnetic character of $R\mathbf{Mn_2X_2}$ (R: rare earth; X: Si, Ge)

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Intermetallic $R\mathrm{Mn_2X_2}$ compounds (R: rare earth; X: Si, Ge) exhibit a variety of temperature-induced magnetic phase transitions and order in diverse magnetic configurations as a result of the exchange interactions between the f and d electronic states. For this reason, these compounds have attracted particular attention and were thoroughly investigated for their magnetic properties.In the present work, we have extended the investigations on the magnetic properties of $R_{1-x}R'_x\mathrm{Mn_2}X_2$ to various rare earth combinations of the silicides to access smaller lattice spacings than those which are accessible with the germanides. We found that the critical lattice spacings determining the type of magnetic exchange are not unique for both germanides and silicides and are affected by the exchange mechanism mediated by Si and Ge onto the Mn sites. Furthermore, the nature of magnetic coupling is found to influence the unit cell dimensions causing c to shrink with the onset of interlayer antiferromagnetic exchange. We provide a general magnetic phase diagram of rare earth silicides and germanides and discuss their properties.