X-ray diffraction study of Ce\textsubscript{T}\textsubscript{2}Al\textsubscript{10} (\textit{T}=Fe, Ru, Os) at high pressures

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1 Introduction

Ce\textsubscript{T}\textsubscript{2}Al\textsubscript{10} (\textit{T}=Fe, Ru, Os) crystallizes in the orthorhombic YbFe\textsubscript{2}Al\textsubscript{10}-type (space group \textit{Cmcm} No. 63) crystal structure [1]. These compounds exhibit a long range ordering with unusually high transition temperature (\(T_0\)) and Kondo semiconducting behavior [2-4]. The long range ordering suddenly disappears under high pressures (at 2 GPa (\textit{T} = Os) and 4 GPa (\textit{T} = Ru)). In order to investigate a structural change around the pressures the order disappears, we performed synchrotron X-ray diffraction study at room temperature under high pressure.

2 Experiment

Single crystals of Ce\textsubscript{T}\textsubscript{2}Al\textsubscript{10} (\textit{T}=Fe, Ru, Os) were grown by using Al self-flux method. The single crystals of Ce\textsubscript{T}\textsubscript{2}Al\textsubscript{10} were crushed into a fine powder. The X-ray diffraction measurements under high pressures were conducted using synchrotron radiation. An imaging plate was used as a detector. The pressure was applied by diamond anvil-type pressure cell. A 4:1 mixture of methanol/ethanol was used as a pressure-transmitting medium. The applied pressure was determined from a pressure shift in the fluorescence spectrum of ruby.

3 Results and Discussion

No additional peak is observed up to 10 GPa on Ce\textsubscript{T}\textsubscript{2}Al\textsubscript{10} (\textit{T}=Fe, Ru, Os), indicating no structural change. Figure 1 shows the lattice parameters of Ce\textsubscript{T}\textsubscript{2}Al\textsubscript{10} normalized at ambient pressure. All lattice parameters decrease monotonically with increasing pressure. The monotonic decrease of lattice parameters indicates that reduction of a long range ordering at 2 GPa on CeOs\textsubscript{2}Al\textsubscript{10} and that at 4 GPa on CeRu\textsubscript{2}Al\textsubscript{10} are not attributed to a structural distortion.

While the decrease ratio of lattice parameters along \textit{a}-axis and \textit{c}-axis are almost the same, that along \textit{b}-axis is the smallest in every compound. The high-energy synchrotron x-ray powder diffraction experiments of LaRu\textsubscript{2}Al\textsubscript{10} clarified the charge density distribution [5]. The charge density around Ru site and Al\textsubscript{5} site are connected along \textit{b}-axis. We propose that the hardness of the lattice parameter along \textit{b}-axis is attributed to this charge density connecting Ru and Al\textsubscript{5} site.

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References


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