Strong anisotropy in the electromagnetic properties of \( \text{Na}_2\text{Ti}_2\text{X}_2\text{O} \) \((X = \text{As, Sb})\) crystals

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— \( \text{Na}_2\text{Ti}_2\text{X}_2\text{O} \) \((X = \text{As, Sb})\) crystals have been grown from the flux method. X-ray diffraction characterization revealed an anti-\( \text{K}_2\text{NiF}_4 \)-type layered structure (tetragonal, space group \( I4/mmm \)) for both compounds. Magnetic susceptibility \((\chi(T))\) and electrical resistivity \((\rho(T))\) measurements revealed major kinks at 115 K \((T_{s1})\) and 320 K \((T_{s2})\) for \( \text{Na}_2\text{Ti}_2\text{Sb}_2\text{O} \) and \( \text{Na}_2\text{Ti}_2\text{As}_2\text{O} \), respectively, signifying possibly the opening of density wave gaps. Both \( \text{Na}_2\text{Ti}_2\text{Sb}_2\text{O} \) and \( \text{Na}_2\text{Ti}_2\text{As}_2\text{O} \) showed remarkably strong anisotropy in their electromagnetic transport properties, and values of \( \gamma_{\rho}(\rho/c/\rho_{ab}) \) even reached 140 and 430, respectively, being much larger than that of iron pnictide \( \text{BaFe}_2\text{As}_2 \) \((\gamma_{\rho} = 2–5)\). The \( \gamma_{\rho} \) of \( \text{Na}_2\text{Ti}_2\text{Sb}_2\text{O} \) changed slightly with cooling, though a small drop at \( T_{s1} \) occurred. In contrast, the \( \gamma_{\rho} \) of \( \text{Na}_2\text{Ti}_2\text{As}_2\text{O} \) changed strikingly by exhibiting not only a small change at \( T_{s2} \) but also a sudden decrease of 50 K, reduced nearly 1/3. Specific heat measurement indicated that \( \text{Na}_2\text{Ti}_2\text{Sb}_2\text{O} \) was only partially gapped with \( \gamma_1 = 4.1 \text{mJ mol}^{-1} \text{K}^{-2} \), though a long-range order was established at \( T_{s1} \), while \( \text{Na}_2\text{Ti}_2\text{As}_2\text{O} \) was fully gapped. The remarkably strong electromagnetic anisotropy revealed in \( \text{Na}_2\text{Ti}_2\text{X}_2\text{O} \) suggests the crucial role of the \( \text{TiO}_2\text{X}_4 \) layer for the transport properties of layered titanium oxypnictides.

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