# Pressure-Enhanced Charge Density Wave Order and Anisotropic Lattice Strain in $BaFe_2Al_9$

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**Abstract**

The hexagonal intermetallic compound $BaFe_2Al_9$ provides an interesting platform to study the coupling between electronic ordering and lattice response under external pressure. In this work, we focus on the pressure evolution of its electrical transport and crystal structure using high-pressure resistivity and synchrotron powder X-ray diffraction measurements. At ambient pressure, $BaFe_2Al_9$ shows a clear resistivity anomaly near 112 K, associated with the onset of charge density wave order. With increasing pressure, this transition shifts systematically to higher temperatures and approaches room temperature at around 3.2 GPa. This behavior is unusual because pressure commonly suppresses charge density wave order, whereas in $BaFe_2Al_9$ it strongly enhances the transition temperature. The low-temperature resistivity follows a Fermi-liquid form, $\rho(T)= \rho_0+AT_2$. The pressure dependence of the residual resistivity and Fermi-liquid coefficient indicates a significant modification of the electronic scattering and suggests a pressure-induced reconstruction of the electronic structure.

High-pressure synchrotron X-ray diffraction measurements performed up to ~7 GPa show that the hexagonal crystal symmetry is preserved over the measured pressure range, with no evidence for a pressure-induced structural phase transition. However, the lattice parameters exhibit anisotropic compression, with a stronger response along the c-axis compared with the basal plane. In addition, the pressure-dependent microstrain parameters show a pronounced change at ~ 3.6 GPa, close to the pressure region where the charge density wave transition reaches room temperature. These results indicate that anisotropic lattice strain plays an important role in stabilizing the high-temperature charge density wave state in $BaFe_2Al_9$. Overall, the combined high-pressure transport and X-ray diffraction results reveal a strong coupling between lattice compression, microstrain, and electronic ordering in $BaFe_2Al_9$, making it a rare example of a three-dimensional intermetallic compound in which pressure promotes charge density wave order.