Uniwersytet Wrocławski

Repozytorium

Plik pochodzi z repozytorium Wydziału Chemii Uniwersytetu Wrocławskiego

Enhancement of magnetic properties of single grain flux-grown icosahedral AlCuFe quasicrystal by shock compression

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Rok wydania

2026

Czasopismo

Acta Materialia

Numer woluminu

311

Strony

122177/1-122177/18

DOI

10.1016/j.actamat.2026.122177

Kolekcja

Naukowa

Język

Angielski

Streszczenie

We report the effects of shock compression and release on the structural and magnetic properties of icosahedral Al–Cu–Fe quasicrystals grown via a self-flux method. A 3 kJ projectile impact modulates the quasicrystalline structure by introducing phason strain without inducing a phase transition, at pressures of 13.4 GPa (first shock) and 21.6 GPa (reflected shock). Magnetic moments and negative Curie–Weiss temperatures of this quasicrystal indicate dilute antiferromagnetic ordering. Shock compression enhanced the = 10 K saturation magnetization, saturation field, and coercive field, suggesting reduced constraint of ideal icosahedral lattice geometry after shock compression. Both pre- and post-shock samples align the easy magnetization direction along the 5-fold axis at high fields, but the shock-compressed sample briefly shifts to a 2-fold axis at 8 T before returning to 5-fold at 9 T. A Fourier expansion retaining harmonics = 1–6 is needed to correctly describe the angular dependence of the magnetic torque in the broad field range 20 mT–9 T. The emergence of the odd Fourier terms is a unique property of quasicrystalline magnetic anisotropy. The magnitudes of the even terms increased two-fold following shock compression.

Słowa kluczowe

Quasicrystal, Magnetism, Shock compression, Anisotropy, Atomic structure

Adres publiczny

http://dx.doi.org/10.1016/j.actamat.2026.122177

Strona internetowa wydawcy

http://www.elsevier.com

Typ publikacji

Artykuł

Plik został wygenerowany dnia 2026-11-14 02:50:44

Adres w repozytorium https://old.chem.uni.wroc.pl/pl/repozytorium/7pPOHNU.