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Why does an almost pure-beryllium alloy exhibit a hundred-fold increase in T_c?

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As one of the lightest elements, beryllium exhibits high-frequency lattice vibrations, a condition for achieving superconductivity (SC) with a sizeable critical temperature. Yet, paradoxically, its $T_c = 0.026$ K is so low, that its SC is often overlooked. Clearly, T_c is affected also by other factors, notably the electron-phonon coupling strength and the density of states (DOS) at the Fermi level $N(\varepsilon_{\rm F})$ (rather low in pure Be). Recently, computational searches have shown that SC is more likely to occur in p^0- and d^1 metals with low-lying empty orbitals. Their electronic properties are predicted to be highly sensitive to structural details, thus resulting in stronger electron-phonon interactions and higher $N(\varepsilon_{\rm F})$ [1]. Based on this intuition, Be-rich alloys may achieve a much higher T_c than elementary Be itself, a prediction which turns out to be true for $ReBe_{22}$, whose $T_c \sim 9.6$ K [2] exceeds by almost 400(!) times that of Be. Here, we report on an extensive study of the physical properties in the normal- and superconducting state of $ReBe_{22}$, by using a series of experimental techniques, in particular muon-spin rotation/relaxation (μSR), as well as numerical density-functional-theory (DFT) band-structure calculations [3]. Our results not only explain the origin of the formidable increase of T_c in $ReBe_{22}$, but also predict exciting developments in case of chemical substitution (of Re with Mo or W) or under high-pressure conditions.

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