Element- and Site-specific Study of the Atomic Origin of Magnetic Hardness in Modern Magnets*

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We combined resonant diffraction and absorption of circularly polarized x-rays to probe the atomic origins of magnetic hardness, or coercivity, in permanent magnetic materials. Modern permanent magnets gain both intrinsic stability against demagnetizing fields and large magnetization through alloying of rare-earth and transition metal ions. The resultant complex crystal structures not only feature more than one magnetic element type but also elements of the same specie in inequivalent crystal sites, making it difficult for even state-of-the-art probes of magnetism to pinpoint the atomic origins of the desirable magnetic properties of these materials. The element specificity of x-ray magnetic circular dichroism, combined with the site selectivity of resonant magnetic diffraction allow for a more thorough understanding of the rare-earth role. We show that the magnetic hardness of currently the best permanent magnet has its atomic origin predominately at one of the two inequivalent Nd crystal sites.

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