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Are the Half Metallic Ferromagnets Half Metallic?

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Since its introduction by de Groot and colleagues in the early 1980s, the concept of half metallic ferromagnetism has attracted great interest. Idealized, half-metals have only one spin channel for conduction: the spin-polarized band structure exhibits metallic behavior for one spin channel, while the other spin band structure exhibits a gap at the Fermi level. Due to the gap for one spin direction, the density of states at the Fermi level has, theoretically, 100% spin polarization. This becomes important to any discussion of applications for materials denoted as half metallic, as half metallic character could imply such materials are 100% spin polarized with small bias voltages. This becomes a common alibi to justify the study of such materials, but is this warranted? Will such materials solve the problem of a high spin polarized source of electrons for spintronic devices? Several classes of materials are currently under investigation as potential high polarization materials. In this talk I will discuss the influence of such finite temperature effects and surface electronic structure on polarization largely for four classes of these potential half metallic systems: NiMnSb(100), CoS_2(100), CrO_2 and $La_{0.65}$(M=Ca, Pb, Sr)$_{0.35}MnO_3$(100). Spin mixing leads to a nonzero density of states in the gap of the insulating spin channel. As a consequence, the ratio of the two spin channels, in the vicinity of the Fermi energy, changes from zero to some finite value that increases with increasing temperature. Gauging the magnitude of the spin polarization at the Fermi level is a challenge and underlying this problem is the need to consider the definition of polarization: not all polarizations are equal. Polarization depends on the measurement. So that the question arises whether these materials are indeed "operationally" better spin injectors than Fe (40%), Co (34%) or even Ni (23%).