Enhanced Exchange Splitting in Magnetic Nano Structures: Co/W(001)

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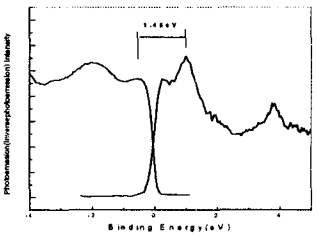
Magnetic films exhibit interesting changes in the magnetic properties when their thickness is reduced to a few atomic layers.[1] This behaviour is dominated by two opposing trends at surfaces and interfaces. An expanded atomic volume at surfaces enhances magnetism by driving it towards the atomic limit, where Hund's rule predicts maximum spin alignment. On the other hand, hybridization with a non-magnetic material at an interface suppresses magnetism. In order to minimize the interface hybridization effect and maximize the surface enhancement, noble metal substrates have been used extensively for thin magnetic overlayers. Going beyond these simpler cases we have chosen a very reactive substrate, i.e. the open W(100) surface, to show the effect of interface hybridization competing with that of surface dilution.



We have used inverse photoemission and photoemission to study the electronic states of Co and Fe on W(100) in the monolayer regime. A c(2×2) structure is found for Co that exhibits a sharp minority spin state at 1.0 eV above the Fermi level, resulting in an enhanced exchange splitting when combined with data from occupied states, which is shown in above figure. The structure of Co on W(100) appears to be similar to that of c(2×2) Cu on W(100), where a surface alloy is formed with Cu substituting in W surface vacancies. If this is true, the enhanced magnetism of Co on W(100) can be explained by an expanded atomic volume in analogy with the enhanced magnetism of the c(2x2) Mn surface alloy on Cu(100) and Ni(100). Fe on W(100) does not form a c(2×2) structure and exhibits a much broader density of unoccupied 3d states than Co. This is indicative of stronger hybridization with W, which quenches magnetism. Comparison with a LDA calculation of layer-resolved density of states has been made.

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References

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