ANL/MSD/PP-74577

Comment* on:

DIRECT OBSERVATION OF SPIN-SPLIT
ELECTRONIC STATES OF Pd AT THE Pd(111)/Fe(110) INTERFACE

Y. Chang, N.B. Brookes, P.D. Johnson

*Physics Department, Brookhaven National Laboratory, Upton, New York 11973
and*

S.D. Bader

Materials Science Division, Argonne National Laboratory, Argonne, IL 60439

The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. W-31-109-ENG-38. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes.

PHYSICAL REVIEW LETTERS - COMMENTS SECTION

jmc

*Supported in part by the U.S. Department of Energy under contract Nos. DE-AC02-76CH00016 and W-31-109-ENG-38 and the National Science Foundation under contract No. DMR-86-03304.

MASTER

REPRODUCTION OF THIS DOCUMENT IS UNLIMITED

**Comment on "Direct Observation of Spin-split Electronic States of
Pd at the Pd(111)/Fe(110) Interface"**

Y. Chang, N. B. Brookes, P. D. Johnson

Physics Department, Brookhaven National Laboratory, Upton, New York 11973

S. D. Bader

Materials Science Division, Argonne National Laboratory, Argonne, IL 60439

The submitted manuscript has been authored under contract no. DE-AC02-76CH00016 with the Division of Materials Sciences, U.S. Department of Energy. Accordingly, the U.S. Government retains a non-exclusive, royalty-free licence to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes.

Comment on "Direct Observation of Spin-split Electronic States of Pd at the Pd(111)/Fe(110) Interface"

In a recent letter, Weber *et al.* ¹ reported the observation of states localized within the interface formed between one atomic layer of Pd and an Fe(110) substrate. By examining the spin polarization, the authors concluded that the states represent an exchange-split pair whose relative binding energy is reversed with respect to that of the substrate bands. The authors noted that this observation is surprising, especially in view of the fact that their own magnetometry measurements indicate a net positive induced Pd moment at the Pd/Fe interface, i.e. a ferromagnetic alignment. They also suggest that a calculation by Huang *et al.* ² of a pseudomorphic Pd monolayer on a three-layer Fe(001) slab agrees qualitatively with their observation, because the calculation indicates a positive moment induced on the Pd as well as an apparent inverted exchange splitting in the spin-resolved density of states. We note, however, that Huang *et al.* ² showed only the spin components of the total density of states, rather than a detailed band structure from which spin exchange splittings for different bands can be obtained.

In any spin-resolved photoemission experiment, the identification of exchange split components requires the demonstration that the states have different spin character and, further, have the same symmetry. The latter observation is made by varying the effective polarization of the incident light and employing symmetry dependent selection rules. It should be noted, however, that the identification of valence states with the same symmetry but different spin character cannot necessarily be used to determine the alignment

or even the existence of a moment. Such information can only be extracted by examining the total spin-dependent density of states.

We have recently studied the interface formed by depositing Pd on an Fe(001) surface using spin-resolved photoemission. LEED studies of this system indicate a p(1x1) overlayer. The detailed results will be presented elsewhere. Here we would like to demonstrate that the spin-resolved interface states Weber *et al.*¹ observed are probably not exchange split components. Figure 1 shows our spin and angle-resolved photoemission spectra taken at normal emission from 1 atomic layer of Pd on Fe(001), with either s- or p-polarized light with photon energy 58 eV. These spectra are obtained with linearly polarized light at an angle of incidence of 35° and 70° respectively. We observe a number of spin-resolved peaks including one majority peak at 1.5 eV binding energy and one minority peak at 1.7 eV binding energy. The latter peak is clearly associated with the overlayer, there being no structure at this binding energy on the clean surface. Coverage dependent spectra show the two peaks in fig. 1 to be localized at the interface. Spectra with 19.5 eV photons (not shown here) show the same two peaks with line shapes very similar to those of Weber *et al.*¹. Thus, the Pd/Fe(001) interface again appears to show an inverted exchange splitting. Examination of fig. 1, however, shows that the two peaks show a different sensitivity to the incident light polarization and hence have a different symmetry. Certainly for this interface then the peaks do not represent an exchange split pair. We suggest that a similar result may be found for the Pd/Fe(110) interface if the symmetry of the states is examined. This would then remove any discrepancy between the measured electronic structure and the magnetometry measurements.

This work was supported in part by the U.S. Department of Energy under Contract Nos. DE-AC02-76CH00016 and W-31-109-ENG-38 and the National Science Foundation under Contract No. DMR-86-03304.

References

1. W. Weber, D. A. Wesner, G. Guntherodt, and U. Linke, Phys. Rev. Lett. **66**, 942 (1991).
2. H. Huang, J. Hermanson, J. G. Gay, R. Richter, and J. R. Smith, Surf. Sci. **172**, 363 (1986).

Figure Caption

Figure 1.

Spin and angle-resolved photoemission valence band spectra of 1 monolayer of Pd on Fe(001), taken at normal emission with 58 eV photons. The upper panel shows the spectrum taken with mainly s-polarized light, and the lower panel shows the spectrum with more p-polarized light. The arrows identify the features at 1.5 and 1.7 eV binding energy, which are not spin-split pairs because of their different polarization dependences.

Intensity (arbitrary units)

DATE

FILMED

5/24/94

END