Characteristic of d-f states in $DyNi_2Mn$ and $ErCo_2Mn$ compounds with strong electronic correlations by resonant photoemission

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Introduction

Investigation of intermetallic compounds have been increasingly attractive due to their structural and magnetic properties and the possibility of developing new functional materials based on them. The compounds RT_2Mn (R = Dy, Er; T = Ni, Co) crystallize in cubic $MgCu_2$ – type structure by alloying 3d transition metal (T) and rare-earth (R). Certain amount of manganese is introduced in compounds of this type led to a change in the characteristics of materials.

We present a study of d- and f-elements interplay and its influence on the electronic structure formation of three-component intermetallic compounds $DyNi_2Mn$ and $ErCo_2Mn$ using resonant X-ray photoemission spectroscopy (RXPS).

The method used allows us to identify the contributions of various components in the valence bands (VB), as well as to study not only the ground state, but also the lifetime of the excited (a core-level hole – VB electron) state and determine energies of the VB single-particle states and two-hole states at selected atoms.

Actuality

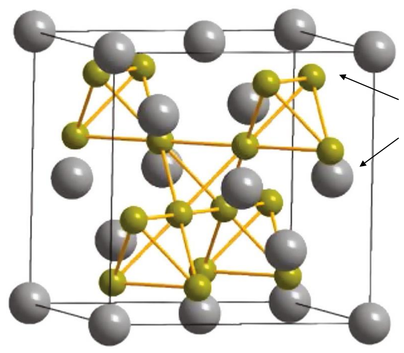

Fig. 1 Crystal structure of $MgCu_2$-type.

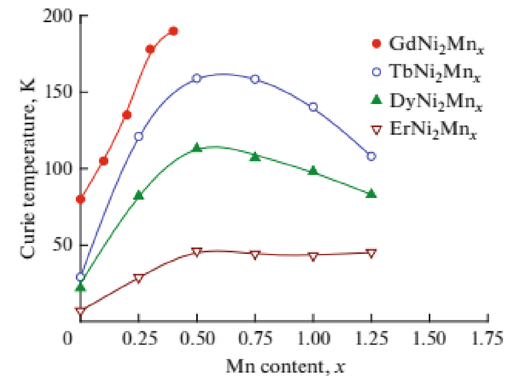

Fig. 2 Concentration dependences of the Curie temperature of RNi_2Mn_x compounds for various R elements.

Manganese introduction into RT-systems does not lead to the crystal structure change, and the Curie temperature dependences on the manganese concentration have a similar form regardless of rare-earth element of the compound.

Direct and resonant photoemission

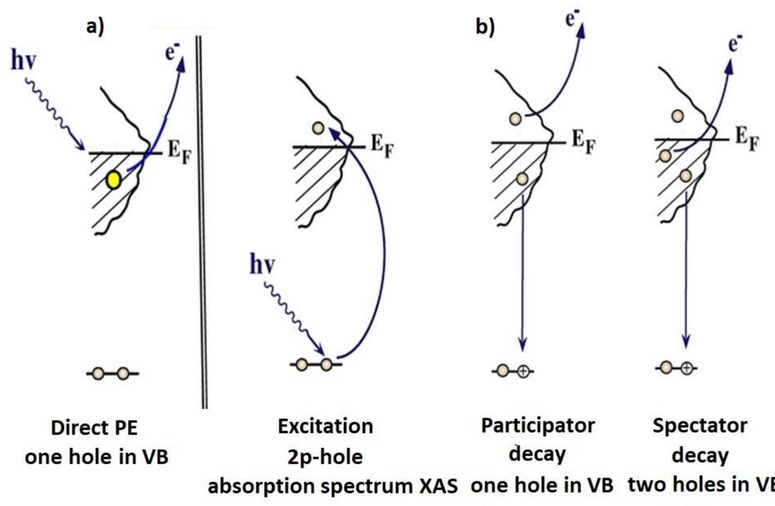

Fig. 3 Direct (a) and resonant (b) photoemission of electrons from the valence band.

XPS spectra of $ErCo_2Mn$

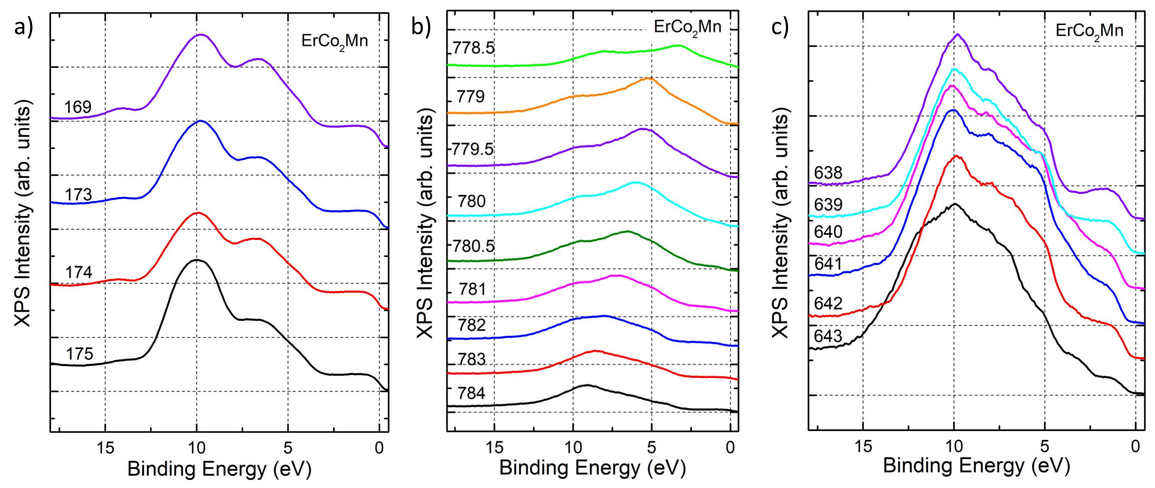

Fig. 4 VB XPS spectra of $ErCo_2Mn$ obtained in excitation threshold region of the Er 4d (a), Co 2p (b) and Mn 2p (c) levels.

XPS and absorption spectra of $DyNi_2Mn$

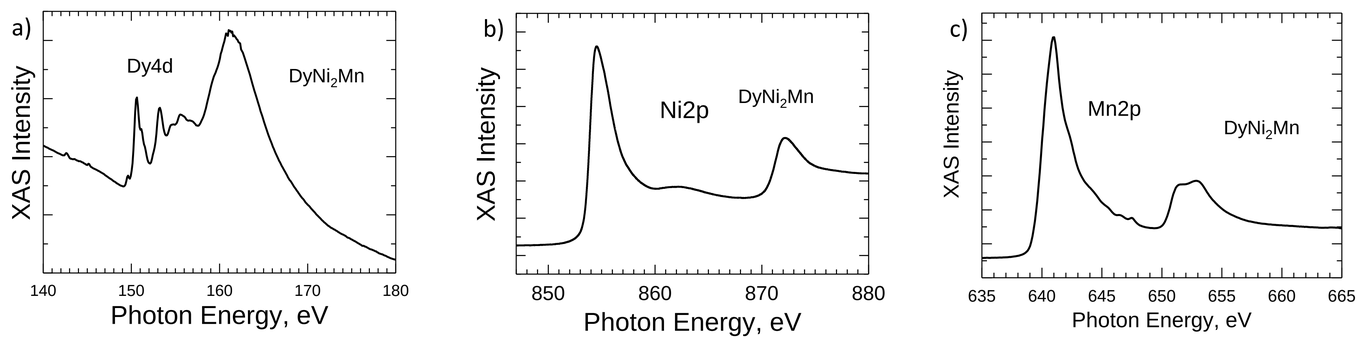

Fig. 5 X-ray absorption spectra in $DyNi_2Mn$.

- Dysprosium absorption spectrum depicts narrow peaks at 150-157 eV corresponding to 4d-4f transitions (fig. 5a). Giant 4d-resonance is observed at maximum of 161 eV (fig. 6a).
- Resonant photoemission spectra and XAS absorption spectra in $DyNi_2Mn$ while crossing the Ni 2p excitation threshold. There is a powerful Auger channel of relaxation (fig. 5b, 6b).
- Resonant photoemission spectra of $DyNi_2Mn$ in excitation threshold region of the Mn 2p and corresponding absorption spectra of manganese (fig. 5c, 6c). Except for sharp increase in the resonance overall intensity (E_{exc} = 641 eV), growing peak with a binding energy of 3 eV is clearly visible and determines Mn 3d-states location in the valence band.

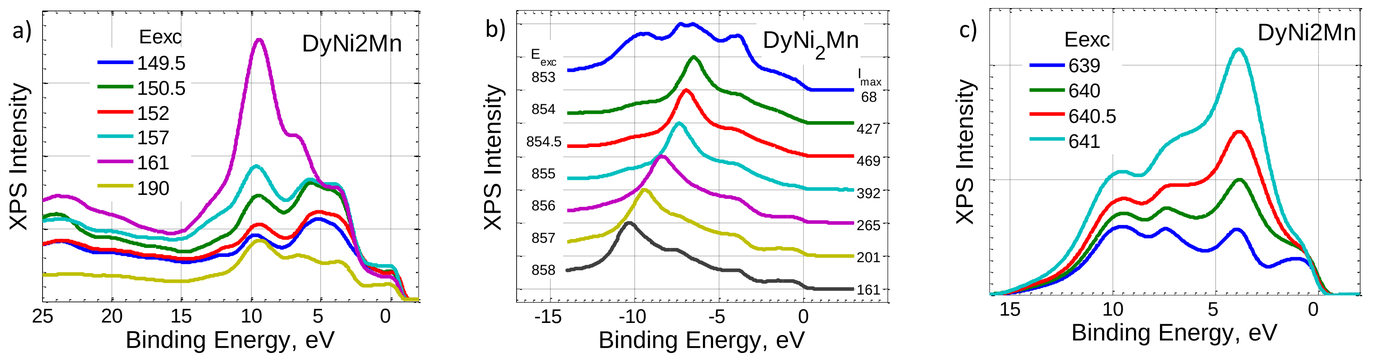

Fig. 6 VB XPS spectra of $DyNi_2Mn$ obtained in excitation threshold region of the Dy 4d (a), Ni 2p (b) and Mn 2p (c) levels.

References

1. J. L. Wang, et.al., Phys. Rev. B **73**, 094436 (2006).
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Acknowledgements

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Conclusions

Resonant photoemission in $DyNi_2Mn$ on nickel atoms is characterized by extremely difficult internal level excitation in atoms with almost filled 3d-states. Thus, photoemission amplification from the VB at the threshold excitation energy is hardly observed. Core photoelectron leaves excited center and resulting photohole decays by the usual Auger process. Manganese states have similar energy comparing to nickel 3d-states and mix with each other forming single zone. 4f valence electrons are hardly hybridized with the transition metals 3d-band.