# Al-Ni-Y metallic glass composite thin films for broad-band uniform reflectivity

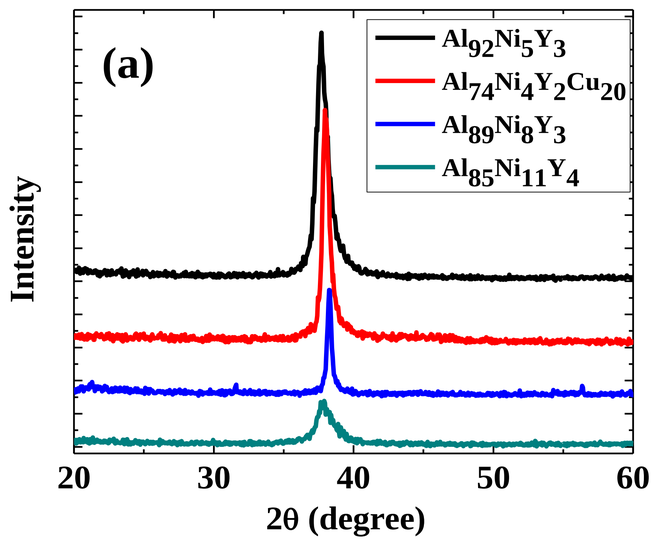
**T. Y. Wei[a], C. M. Chang[b], C. C. Yu[c], C. H. Wang[d], J. H. Hsu[e], and J. C. Huang[f]**

*Department of Materials and Optoelectronic Science, National Sun Yat-Sen University, Kaohsiung 80424, Taiwan*

## Abstract

The Al-Ni-Y thin film metallic glasses are manufactured by sputtering for the first time, and their optical reflectivity characteristics are explored. The relationship among composition, atomic structure and reflectivity performance is established. Compared with pure Al films, the Al-Ni-Y film surface roughness is much lower and hardness is much higher, more suitable for optical reflector applications. For composite Al-Ni-Y films, the reflectance varies within 80-91%. For fully amorphous films, the reflectivity exhibits unusual uniform reflection at ~70%, perfect for broad-band filter.

## Results and discussion



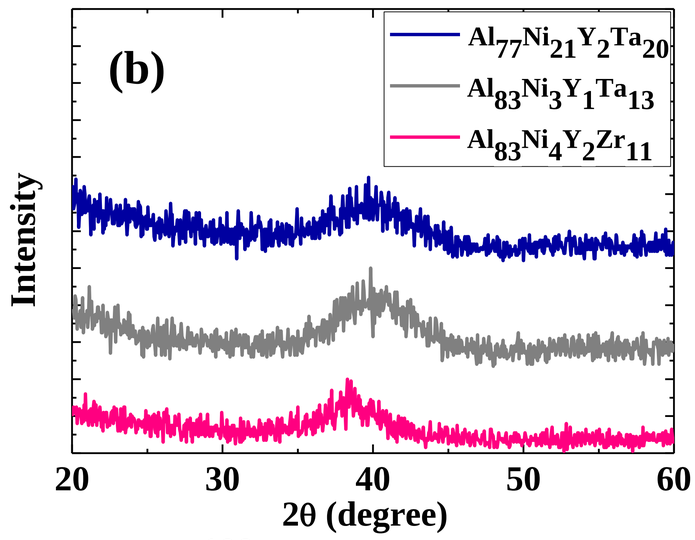




Fig. 1. XRD patterns for the Al-based films: (a) the group showing the composite structure with the Al nanocrystalline embedded in the amorphous matrix, and (b) the other group possessing the fully amorphous structure.

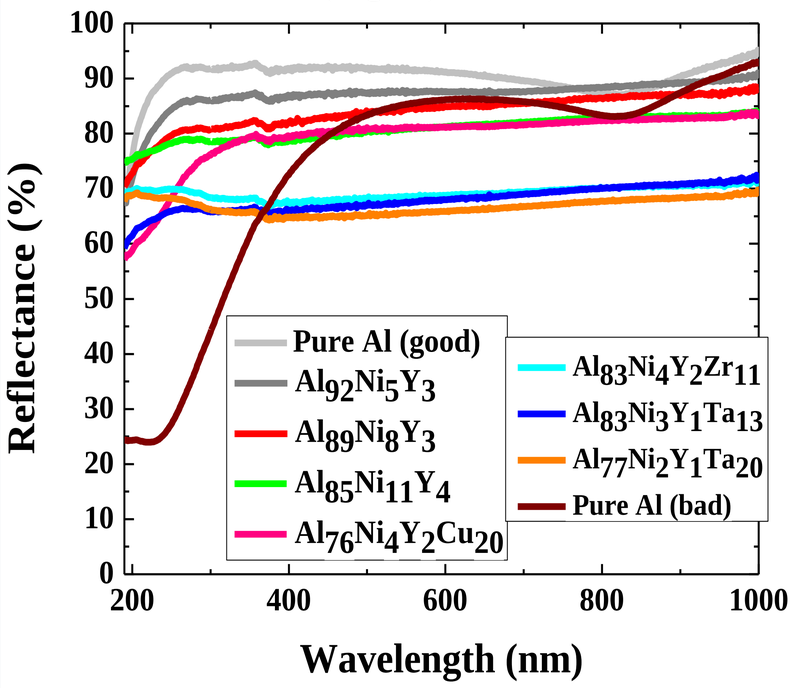



Fig. 3. The reflectance of the pure Al and the various Al-based amorphous or composite thin films.

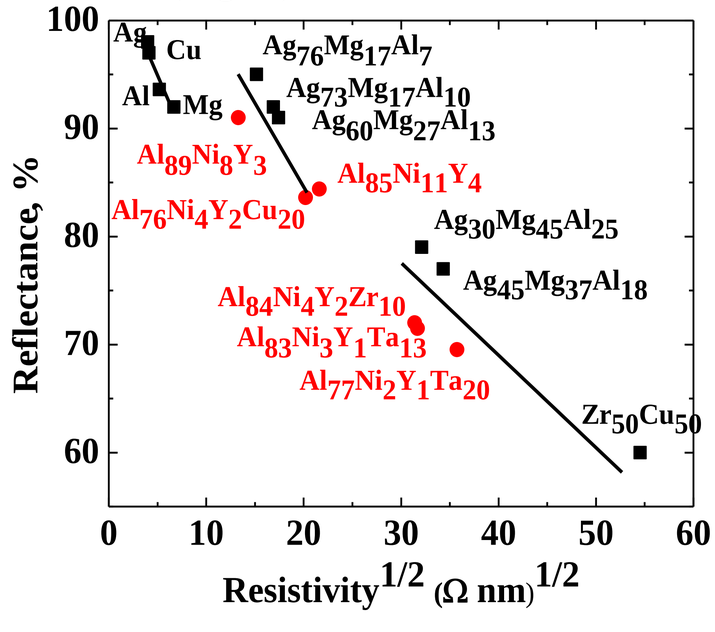



Fig. 4. The dependence of light reflectance as a function of electric resistivity. The previous data reported are presented in black color and fit by the solid lines. The new data obtained in this paper are indicated in red color.

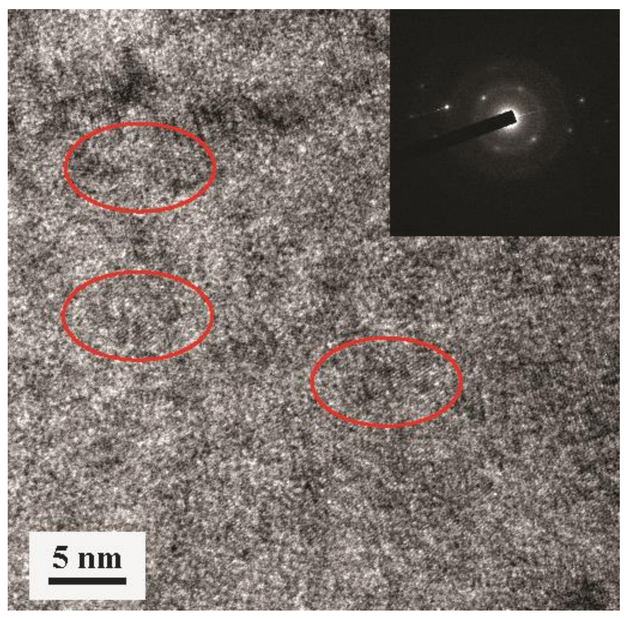



Fig. 2. The representative high-resolution TEM lattice image, with an inserted electron diffraction pattern, taken from the $Al_{89}Ni_8Y_3$ thin film, showing the typical Al crystalline grains about 5 nm embedded in the amorphous matrix.

## Conclusions

In summary, no matter fully amorphous or composite, the film surface roughness is always much lower, and the surface hardness is always much harder (by six times) than those of the pure Al films. The high-quality featureless flat surface is quite suitable for the optical reflector or filter applications. The optical reflectance of the Al-Ni-Y based films, with the MG/NC composite structure, is nearly constant in the light wavelength range from UV to IR with reflectance slightly varying within 80-91%. And the reflectivity of the fully amorphous Al-Ni-Y based films exhibits the unusual highly uniform characteristic at ~70% over the entire wavelength range from 200 nm to 1000 nm, shining light on a new application for uniform light filter merit for the very wide range from UV to IR regime. The MG/NC composite atomic structure, which depends on the film composition, can serve as a simple controllable parameter for various optical reflector/filter requirements.