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The Effect of Intermixing on the Interface Stress in Ag/Ni Multilayers

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Beamline(s): X22C

Introduction: The {111} interface stress in Ag/Ni multilayers has been determined to be approximately –2 N/m [1]. This negative interface stress indicates that the interface *pushes out*, and various models have suggested reasons for this [2, 3]. However, a spurious value of the interface stress can arise if there exists intermixing between the Ag and Ni layers that is unaccounted for [4]. The purpose of this experiment is to examine to what extent intermixing occurs in Ag/Ni multilayers.

Careful consideration of the deposition process leads to the conclusion that should there be intermixing between the Ag and Ni, a compositional gradient must exist between the elemental layers. One way of determining the nature of the compositional gradient is by specular reflectivity accompanied by diffuse scattering.

Results: Figure 1 shows the results from a Ag/Ni multilayer with a 42 Å bilayer thickness. The open circles in Figure 1 (*a*) and (*b*) are the data from specular reflectivity and longitudinal diffuse scatter, respectively. All spectra were taken with x-ray energies far from (8020 eV) and near to (8320 eV) the Ni absorption edge to effect a change in the Ni atomic scattering factor. Reflectivity fits and diffuse scatter simulations are shown as the solid lines in Figure 1 (*a*) and (*b*), respectively.

Conclusions: Our fits and simulations show that the widths of the intermixed layers ranges from 2.5 to 3 Å (i.e., 1.1 to 1.4 monolayers) at both the Ag/Ni and Ni/Ag interfaces. The effect of these interlayers on the interface stress is negligible when compared to the standard deviation of the measurement. Thus, the interface stress is indeed compressive, and the models used to explain this should be given further consideration.

References:

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3. Q. Jiang et al., Acta Mater., **49**, *3143*, 2001.
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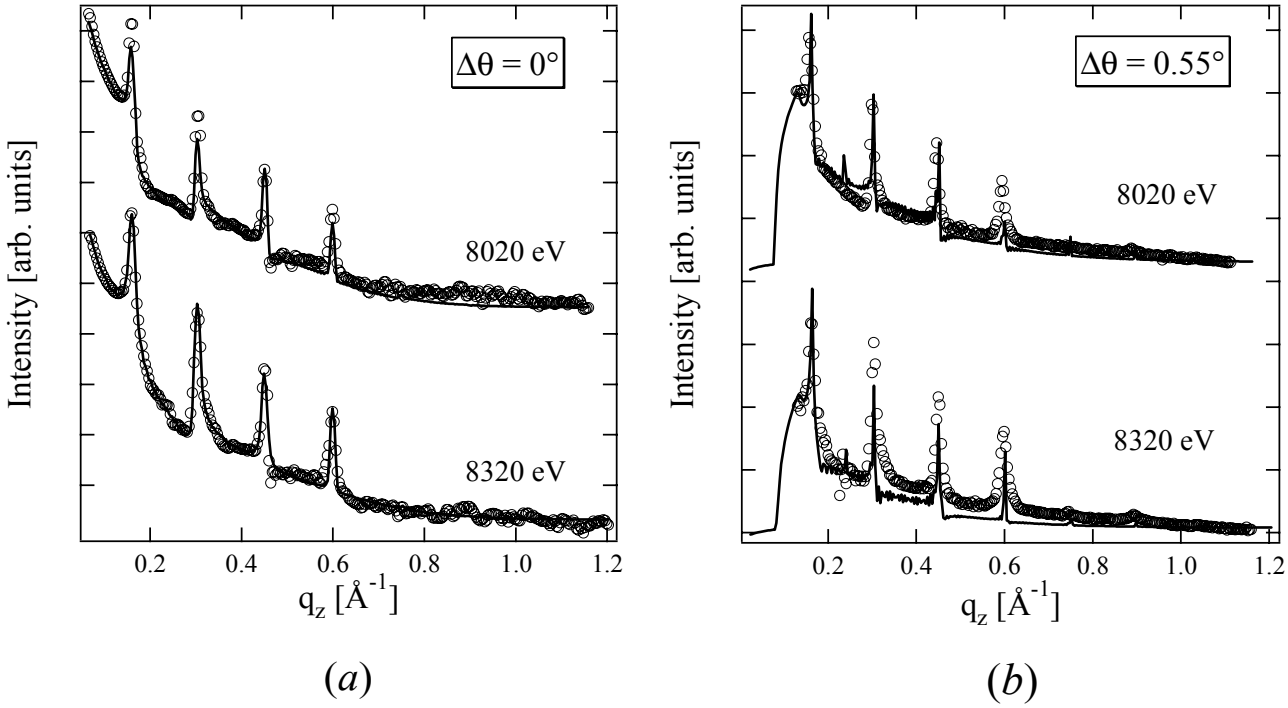

Figure 1. Specular reflectivity (*a*) and longitudinal diffuse scattering profiles (*b*). The tilt of the sample from the specular condition is indicated by Δθ, and the x-ray spectra taken at E = 8020 eV and E = 8320 eV are offset. The data and fitted/simulated profiles are given by the open circles and solid lines, respectively.