NEUTRON DIFFRACTION STUDIES

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SCATTERING CROSS SECTION AND PHASE OF SCATTERING FOR Ni^{58} AND Ni^{60}

Various scattering cross-section determinations for Ni have indicated a much larger scattering than suggested by simple potential scattering. Normal nickel contains two major isotopes, Ni^{58} (68.0%) and Ni^{60} (27.2%), along with the minor isotopes Ni^{61}, Ni^{62}, and Ni^{64}. In attempting to assign the anomalous scattering cross section to a particular isotope, samples of $Ni^{58}O$ and $Ni^{60}O$ were obtained from the Isotopes Production Division at Y-12 and were examined in the neutron diffraction spectrometer.

Figure 1 shows the diffraction patterns obtained for the three nickel oxide preparations consisting of Ni^{58}, Ni^{60}, and normal Ni. The experimental data for the three samples have been corrected for specimen weight, absorption, etc., so that the patterns are directly comparable. Since nickel oxide crystallizes in the NaCl-type face centered cubic structure, a comparison of the (111) and (200) intensities permits a direct determination of the phase of scattering of the nickel isotopes. It is seen in Figure 1 that the (200 reflection is stronger than the (111) reflection for all three specimens, and hence it follows that Ni^{58}, Ni^{60}, and elemental Ni scatter neutrons with positive phase, the same as does oxygen. It is also seen that the patterns differ markedly in intensity, signifying that the scattering cross sections are widely different. From the measured intensities of the diffraction peaks, the coherent scattering cross sections for Ni^{58}, Ni^{60}, and elemental Ni have been determined as 27, 2, and 14 barns respectively. Since potential scattering according to the physical size of these nuclei should contribute a scattering cross section of only about 5.7 barns, it is seen that the anomalously high scattering for nickel is caused by the Ni^{58} isotope, in spite of the fact that the scattering by Ni^{60} is lower than the expected potential scattering.

Both Ni^{58} and Ni^{60} are even-even nuclei with presumably zero spin, and hence their coherent scattering cross sections should be the same as their total scattering cross sections. From transmission measurements on the nickel oxide samples, the total scattering cross sections for Ni^{58}, Ni^{60}, and elemental Ni were determined as 25, 3 and 17 barns respectively, as shown in Table 1.

The agreement between the two cross-section values for Ni^{58} is satisfactorily within experimental error, while the presence of uncorrected residual water in the Ni^{60} sample makes the total scattering larger than the coherent scattering. It would not be expected that the total and coherent scattering for elemental Ni should be the same because of isotopic