Acta Cryst. (1972). A**28**, 473

Coherent neutron-scattering amplitudes for ^{24}Mg, ^{25}Mg and ^{26}Mg isotopes. By A. Abul Khail, F. A. Amin, A. Al-Naimi, A. Al-Saji and G. Y. Al-Shahery, *Iraq Atomic Energy Comission, Nuclear Research Institute, Tuwaitha, Baghdad, Iraq*, and V. F. Petrunin and M. G. Zemlyanov, *USSR Atomic Energy Committee, I. V. Kurchatov's Atomic Energy Institute, Moscow, USSR*

(*Received* 7 *January* 1972)

Enriched powder samples of MgO containing 98·5% of ^{24}Mg, 92% of ^{25}Mg and 87% of ^{26}Mg have been examined and have yielded the following scattering lengths for the individual isotopes at a wavelength of 1·02 Å, in barns: ^{24}Mg, $b=0·549\pm0·018$; ^{25}Mg, $b=0·362\pm0·014$; ^{26}Mg, $b=0·489\pm0·015$. A value for b of $0·523\pm0·017$ for ordinary magnesium is deduced.

The value of the coherent neutron-scattering amplitude of magnesium has been known only for the natural mixture of isotopes (Bacon, 1969; Sabine, 1963). In this study an attempt was made to measure coherent neutron-scattering amplitudes of ^{24}Mg, ^{25}Mg and ^{26}Mg. All magnesium isotopes under investigation had the form of magnesium oxides MgO which possess a face-centred cubic structure of the type NaCl. Such a structure is convenient (Bacon, 1962) since the structure factor, and consequently the diffraction maximum intensities on a neutron pattern, are proportional to the square sum of magnesium and oxygen coherent scattering amplitudes b_{Mg} and b_O when the Miller indices of the reflecting plane (hkl) are even, or to the square difference of these amplitudes when the Miller indices are odd. Knowing the value of the coherent neutron-scattering amplitudes of oxygen, $b_O=0·577$ barns (Bacon, 1969) one can determine the coherent neutron-scattering amplitudes for magnesium isotopes by using the ratio of even to odd maximum intensities on a single neutron pattern without any additional measurements.

The investigated powder samples had the following compositions with respect to magnesium isotopes:

Samples	^{24}Mg %	^{25}Mg %	^{26}Mg %
1	98·5	0·9	0·6
2	4·3	92·0	3·7
3	11·4	1·3	87·3

The total of other impurities in the original samples is less than 0·1%. However, since magnesium oxide is very hygroscopic the investigated samples have formed a small amount of hydroxide despite the precautions undertaken during filling. Therefore, a quantitative X-ray diffraction phase analysis has been made, and the insignificant contribution of hydroxide to neutron diffracted patterns subtracted as well as the aluminum container contribution.

Neutron-diffraction studies on all isotopes have shown that the diffraction maximum intensities with odd Miller indices are significantly less than those with even indices. This indicates that the sign of the coherent scattering amplitudes for all three isotopes is positive. Besides, the values of the odd diffraction maximum intensities on the neutron patterns of ^{24}MgO and ^{26}MgO are very small, and these intensities are scarcely distinguishable above the background level which shows that the coherent scattering amplitude values for isotopes ^{24}Mg and ^{26}Mg are almost the same as for oxygen. On the neutron-diffraction pattern of MgO^{25} the diffraction maximum intensities are sufficiently high to be measured with a good statistical accuracy (1·3%). It is therefore only for ^{25}Mg that the coherent scattering amplitudes have been calculated by the more accurate method mentioned above for the intensity ratio of the largest even and nearby odd maximum 200 and 111, 222 and 311. As far as the isotopes ^{24}Mg and ^{26}Mg are concerned, their amplitude values have been calculated by comparing the strongest maximum intensities (200) on the neutron patterns of ^{24}MgO, ^{26}MgO with the value of the identical maximum intensity on the neutron pattern of ^{25}MgO. As a thermal factor value for all samples, the Debye temperature value 750°K (Sagel, 1958) has been used.

It should be noted that since the diffraction maximum intensity depends on the square value of the coherent scattering amplitudes, there appear two possible values for b_{Mg} corresponding to the positive and negative signs of the square root from the intensity ratio. The choice has been made through additional measurement under identical experimental conditions of the neutron-diffraction pattern of nickel as a reference standard. As a result, the values of the coherent neutron-scattering amplitudes measured in barns at the wavelength $\lambda=1·02$ Å have been obtained as follows: $b_{24_{Mg}}=0·547\pm0·018$, $b_{25_{Mg}}=0·380\pm0·014$ $b_{26_{Mg}}=0·476\pm0·015$. Since only these three stable isotopes for magnesium are known in nature, and taking into consideration the above-mentioned isotopic composition of the investigated samples, one can predict the value for 100%-enriched isotopes: $b_{24_{Mg}}=0·549\pm0·018$, $b_{25_{Mg}}=0·362\pm$ 0·014, $b_{26_{Mg}}=0·489\pm0·015$. The value of the coherent neutron scattering amplitude for the natural mixture of magnesium isotopes will thus be equal to $0·523\pm0·017$, which is in good agreement with previous values 0·52 (Bacon, 1969) and 0·516 (Sabine, 1963).

References

Bacon, G. E. (1969). *Acta Cryst.* A**25**, 391.

Bacon, G. E. (1962). *Neutron diffraction.* Oxford: Clarendon Press.

Sabine, T. M. (1963). *Acta Cryst.* **16**, 834.

Sagel, K. (1958). *Tabellen für Röntgenstrukturanalyse.* Berlin: Springer-Verlag.