Short Communications

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The coherent neutron scattering amplitude of ^{15}N.

By MOSHE KUZNIETZ, *Physics Department, Imperial College, London SW7 2BZ, England* and F. A. WEDGWOOD, *Materials Physics Division, A.E.R.E. Harwell, Didcot, Berkshire, England*

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The coherent neutron scattering amplitude of ^{15}N has been determined by neutron diffraction from powdered sample of $U^{15}N$ at room temperature. The value obtained is $b_{(^{15}N)} = (0{\cdot}65 \pm 0{\cdot}02) \times 10^{-12}$ cm.

Nitrogen is an important ingredient of many organic molecules. Since designated substitution of the two naturally occuring nitrogen isotopes ^{14}N (99·635%) and ^{15}N (0·365%) can be valuable in understanding the structure and some processes in organic molecules, it is important to know the coherent neutron scattering amplitudes of both isotropes for interpreting neutron scattering and diffraction experiments on these molecules. The coherent neutron-scattering amplitude of ^{14}N, which should apply also for natural nitrogen, is tabulated by the Neutron Diffraction Commission (1969) as $0{\cdot}94 \times 10^{-12}$ cm.

We have determined the coherent neutron-scattering amplitude of ^{15}N from the room-temperature neutron-diffraction patterns of ^{15}N-enriched uranium mononitride ($U^{15}N$). The measurements were carried out at Harwell. The $U^{15}N$ sample was prepared by R. A. Potter and T. G. Godfrey of the Metals and Ceramics Division, Oak Ridge National Laboratory, Tennessee, U.S.A., by reacting powdered depleted uranium with nitrogen gas containing at least 99% of ^{15}N. The sample was provided by Dr W. Fulkerson of Oak Ridge and was previously used for n.m.r. studies (Kuznietz & Van Ostenburg, 1970). We used up to 6 g of the powdered sample in a vanadium container for the measurements. The sample had less than 1% of secondary phases (including oxides).

In the first neutron-diffraction study on powdered UN containing natural nitrogen, Mueller & Knott (1958) verified the NaCl-type crystallographic structure. They could not detect any of the *hkl* all-odd nuclear reflexions, a fact which is consistent with the close neutron-scattering amplitudes of N ($0{\cdot}94 \times 10^{-12}$ cm) and U ($0{\cdot}84 \times 10^{-12}$ cm). Based on these scattering amplitudes (b), the intensity $I(200)$ of the 200 nuclear reflexion should be about 200 times the intensity $I(111)$ of the 111 nuclear reflexion, the latter being too small to be detected. Uranium mononitride orders in the type-I antiferromagnetic structure below 50°K (Curry, 1965), and a high neutron background is observed due to paramagnetic scattering at room temperature. $U^{15}N$ seems to be a suitable compound for determination of $b_{(^{15}N)}$ since uranium mononitride has a small homogeneity range and is close to stoichiometry at temperatures up to about 1400°K (Bugl & Bauer, 1964; Scarbrough, Davis, Fulkerson & Betterton, 1968).

In our diffraction patterns of $U^{15}N$ the all-odd reflexions 111 and 311 were clearly observed. In seven runs at two neutron wavelengths (1·178 and 1·065 Å) we measured the ratio $I(200)/I(111)$ as 36·0, 31·6, 36·6, 36·3, 31·6, 34·8 and 31·8. The average value of $I(200)/I(111)$ is 34 ± 2, from which we deduce the ratio:

$$\pm \frac{b_U + b_{(^{15}N)}}{b_U - b_{(^{15}N)}} = 7{\cdot}76 \pm 0{\cdot}25 \,. \tag{1}$$

This ratio suggests that $b_{(^{15}N)}$ is either $(0{\cdot}648 \pm 0{\cdot}005) \times 10^{-12}$ or $(1{\cdot}09 \pm 0{\cdot}01) \times 10^{-12}$ cm. To decide between these two values, we made an absolute intensity comparison between the 200 nuclear reflexion of $U^{15}N$ and the 111 and 200 nuclear reflexions of Ni metal and of NiO, both in the powder form. From these measurements we obtained values for $b_{(^{15}N)}$ of $(0{\cdot}75 \pm 0{\cdot}15) \times 10^{-12}$ and $(0{\cdot}7 \pm 0{\cdot}2) \times 10^{-12}$ cm and thus chose the lower of the two more accurate results quoted above.

The Debye–Waller exponents (B) were calculated as they affect the result in a small way. From six Bragg peaks we obtained $B_U \sim 0{\cdot}15$ Å^2 and $B_N \sim 0{\cdot}4$ Å^2. Introduction of these values alters the ratio (1) to 8·01 and the effect on $b_{(^{15}N)}$ is to change it to $0{\cdot}653 \times 10^{-12}$ cm. This change is negligible. The Debye–Waller results confirm our choice of $b_{(^{15}N)} < b_U$ since the reverse would lead to $B_U > B_N$ which is most unlikely.

Taking into account the small uncertainties in stoichiometry and isotropic purity we therefore conclude that the coherent neutron-scattering amplitude of ^{15}N is $(0{\cdot}65 \pm 0{\cdot}02) \times 10^{-12}$ cm.

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References

BUGL, J. & BAUER, A. A. (1964). *J. Amer. Ceram. Soc.* **47**, 425.

CURRY, N. A. (1965). *Proc. Phys. Soc.* **86**, 1193.

KUZNIETZ, M. & VAN OSTENBURG, D. O. (1970). *Phys. Rev. B*, **2**, 3453.

MUELLER, M. H. & KNOTT, H. W. (1958). *Acta Cryst.* **11**, 751.

NEUTRON DIFFRACTION COMMISSION (1969). *Acta Cryst.* A**25**, 391.

SCARBROUGH, J. O., DAVIS, H. L., FULKERSON, W. & BETTERTON, J. O. JR (1968). *Phys. Rev.* **176**, 666.