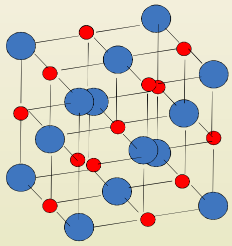
Structure Analysis Experiment Using Ultrasonic Waves

Introduction

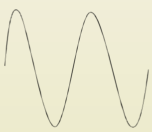
This is the crystal structure of NaCl.

We usually measure the distance between Na and Cl(I call it *d*) by using X-rays.

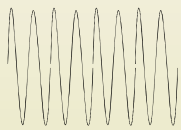


But I was not able to use X-rays because it was too dangerous and expensive for me .

I thought I could measure *d* by using sound waves because X-rays and sound waves are both waves.

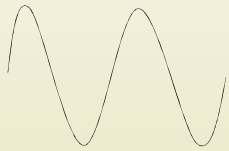


sonic waves



ultrasonic waves

I had a model experiment using sound waves because the wavelength of X-rays and the *d* of NaCl are far shorter than those of sound waves.



sound waves

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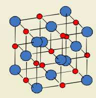


d of NaCl

I used ultrasonic waves

The wavelength of ultrasonic waves is short among sound waves.
The experiment should not be obstructed by noise.

↓

I was able to experiment something similar to it without using X-rays.

Principle of the structure analysis

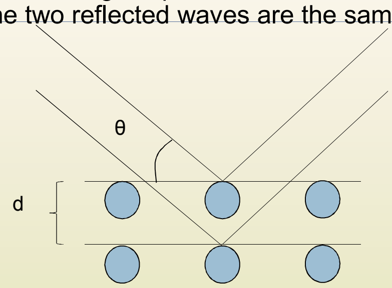
Application of Blag's equation

$$2d\sin\theta = n\lambda\ (n=1,2,3\ldots)$$

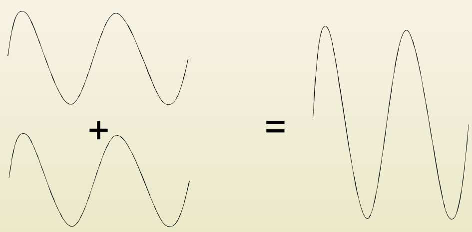
d:Distance *θ*:Angle of incidence

λ:Wavelength

When Blag's equation is established, the two reflected waves are the same.



When this equation is established, the same waves make each other stronger.



Experiment

I made ultrasonic waves go into the model which is likened to the crystal of the NaCl(lined nails).

I changed the angle of incidence and measured the intensity of the reflected waves.

Instruments

- An ultrasonic waving machine (*f*=40kHz)
- Model of the crystal of the NaCl(*d*=1.0×10-3 m)
- A protractor

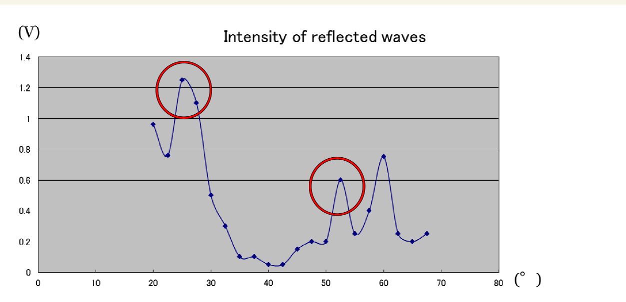
$v = 331.5 + 0.6t \quad t = 15℃$ ⇒ $v = 3.4\times10^{2}[\mathrm{m/s}]$

$\lambda = \frac{v}{f} = 8.5\times10^{-3}[\mathrm{m}]$

v:Velocity
t:Temperature
f:Frequency
λ:Wavelength

The model of NaCl

Result



- From this graph, the reflected waves
- at*θ*=25° 52.5° are the strongest.

From Blag's equation,

- From *θ*=25° *d*=1.0×10^{-3}m
- From *θ*=52.5° *d*=1.1×10^{-3}m

- The real *d*=1.0×10^{-3}m

Conclusion

It is also possible to measure *d* in a model experiment using ultrasonic waves.