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A Neutron Emission from Lithium Niobate Fracture

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We studied neutron emission from a crushing process of a Lithium-Niobate($LiNbO_3$) single crystal in deuterium gas atmosphere. We observed excess neutrons 3 counts / h with a confidence level of 99.95% that correspond 120 neutrons / h emission from process.

In a solid crushing process, chemical bonds are broken and ionic charges appear on the crushing surface. An activate state is induced by these charges. The mechanochemical reaction induced extraordinary chemical reactions. The charge may generate high electric field. Deuterons are accelerated by the field and collide with target deuterides. Consequently, nuclear fusion occurs and neutrons emits. Kluev et al. and Derjaguin et al. have reported neutron emissions from deuterated metal due to the mechanochemical process.[1,2)]

We report neutron emission from a crushing process of high piezoelectric materials in deuterium gas using a vibromill. We chose a single crystal of lithium niobate as the piezoelectric material. It has a high piezoelectric strain constant of 6.92×10^{-11} C/N(d_{15}) and a relatively low dielectric constant of 85.2(X_{11}^{T}). The generated voltage by forcing on the piezoelectric material is proportional to the piezoelectric strain constant and inverse proportional to the dielectric constant. A high piezoelectric constant and low dielectric constant are necessary to generate high voltage. The low conductivity ensures the charge retain after the charge unbalance of the fracturing process.

The vibromill(VP-100,ITOH Co. Ltd.) was composed of a 200 cm^3 cup and a stainless steel ball (50 mm diameter) which vibrated at the frequency of 50 Hz with the vertical amplitude of 3 mm.

The emitted neutrons were detected by 10 ^{3}He proportional counters arrayed circularly in a cylindrical shaped paraffin block of 38 cm outer diameter and 10 cm inner diameter. The neutrons thermalized by the paraffin and reacted with ^{3}He making a proton and a tritium with a Q value of 760 keV.

The pulse heights of output signals of the ^{3}He counters were digitized by analog to digital converters. The vibromill was set in the center of the cylindrical paraffin. The pulse height distribution of ^{252}Cf is shown in Fig. 1 (a). In order to increase the signal to noise ratio, counts between 600 and 1599 channels were selected. The detection efficiency was measured to be 2.6% by a calibrated ^{252}Cf source.

The experiment was done in the low background facility at Nokogiri mountain of The Cosmic-ray Research Institute, The University of Tokyo. It was located underground at the depth of 100 m water equivalent. The average count rate of the background neutrons were observed 7.6 counts / h during 132 h. The crushing for a sample was continued 1 hour duration. The crystal of lithium niobate was ca. 3 mm granule initially and after 15 min crushing the size was reduced to ca. 1 µm diameter. Figure 1 (b) shows the excess neutrons pulse height distribution of the summation of 12 samples of lithium niobate + deuterium gas. It was compared with normalized 12 h background taken during 132 h. The sum of between 1600 and 4000 channel counted neutron were scarcely slight 1.5. However from 600 to 1599 channel counted neutrons were obviously excess 34.8.

Table 1 shows the experimental results 14 samples on crushing process. Derjaguin et al.[2] observed excess neutron emission on Ti+D_2O system. However we did not observe excess neutron in Ti+D_2O or Pd+D_2O systems. On the lithium niobate + deuterium gas system, we observed excess neutron emission over the background neutrons. For intensify of the density of deuterium atoms, we add a lithium deuteride in the system.

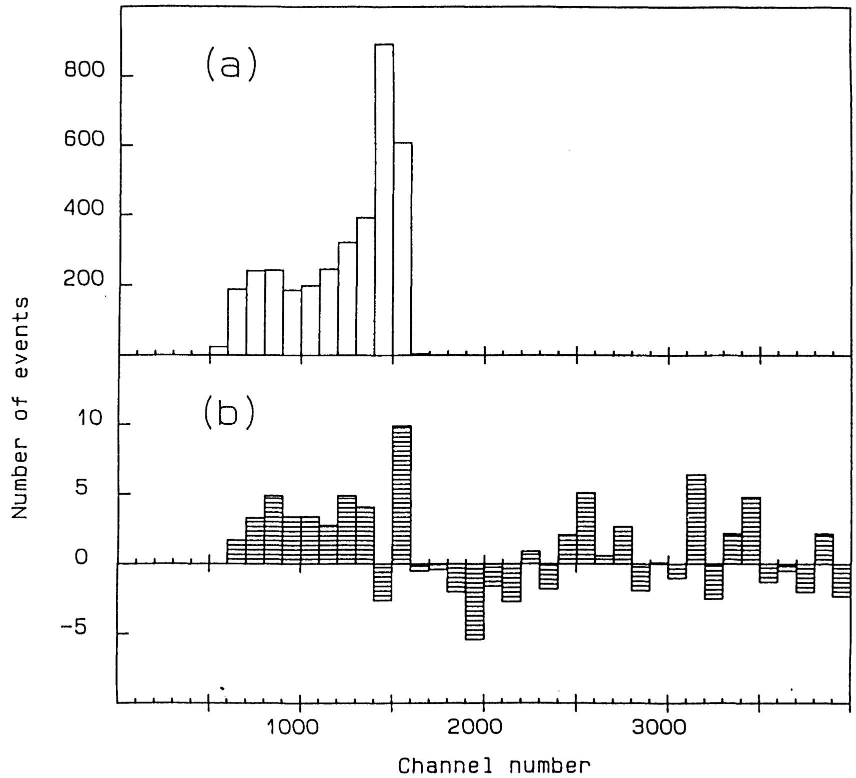

Fig. 1. (a) ^{252}Cf emitted neutron distribution of counts over the channels of pulse height analyzer. The peak of 1400 channel in pulse height distribution corresponded the energy of 760 keV thermalized neutrons.
(b) Pulse height distribution of excess emitted neutrons summation over lithium niobate + deuterium gas 12 samples. A neutron spectra was observed at 500-1600 channels. Reference was used 12 h averaging value background neutrons from 132 h duration.

Also, on the lithium niobate + lithium deuteride + deuterium gas system, we observed excess neutrons. All the counts of the 12 runs of lithium niobate + deuterium gas system were 126 compared to the expected background of 91.2. If our observed background neutrons fluctuation was Gaussian distribution, we can calculate mean and standard deviation 91.2 and 9.5 respectively. The value 126 corresponds 0.05% probability if it was fluctuation of the background neutrons. So, we observed 34.8 excess neutrons in crushing process with provability of 99.95%. It is assumed that these neutrons were emitted by a fusion of the collision of accelerated deuterium at high voltage field in crushing process of high piezoelectric material.

Table 1. Samples and observed neutrons

Sample and amount	Neutrons (counts/h)
Ti 5 g + D_2O 8 ml	4
Pd 5 g + D_2O 8 ml	5
$LiNbO_3$ 12 g + D_2 101 kPa	11
$LiNbO_3$ 13 g + D_2 101 kPa	12
$LiNbO_3$ 15 g + D_2 1.1 kPa	18
$LiNbO_3$ 15 g + D_2 6.6 kPa	12
$LiNbO_3$ 20 g + D_2 16.6 kPa	11
$LiNbO_3$ 16 g + D_2 13.2 kPa	5
$LiNbO_3$ 10 g + D_2 24.7 kPa	8
$LiNbO_3$ 10 g + D_2 25.7 kPa	9
$LiNbO_3$ 15 g + D_2 101 kPa	9
$LiNbO_3$ 12 g + D_2 101 kPa + LiD 2 g	10
$LiNbO_3$ 12 g + D_2 101 kPa + LiD 2 g	13
$LiNbO_3$ 13 g + D_2 101 kPa + LiD 2 g	8

We conclude that the excess neutrons (average 3 neutrons / h) were observed by the mechanochemical crushing process of lithium niobate in deuterium gas with the confidence level 99.95%. It is assumed that a D-D fusion reaction was occurred in crushing process.

References

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