

Study of the Nanotechnology in Manufacture of Generators

Abstract. With the development of science and technology, the smaller sizes generator, the more attention by people. The main purpose of this article is to manufacture three-phase nanogenerator and piezoelectric nanogenerator under vibration, and their working principle are introduced and their performances are studied. The results show that, using the present nanomaterials, three-phase nanogenerator and piezoelectric nanogenerator can be prepared. In ambient vibration condition, piezoelectric materials produce larger rated current and voltage. However, copper laps cutting magnetic line of force produce less rated current and voltage. So the piezoelectric nanogenerator can be separately used to supply power. It may produce higher voltage, current and power if three-phase nanogenerator and piezoelectric nanogenerator in series-parallel connection, and there is commercial value.

Streszczenie. Przedstawiono możliwości wytwarzanie trzyczłonowego i piezoelektrycznego generatora w nanotechnologii. Przy typowych wibracjach materiały piezoelektryczne mogą służyć jako generatory napięcia i prądu. Przedstawiono możliwości połączenia obu generatorów w jeden system. (Studium możliwości wytwarzania generatorów z wykorzystaniem nanotechnologii)

Keywords: Three-phase; Piezoelectric Materials; Nano; Generators; Power

Słowa kluczowe: nanotechnologia, materiały piezoelektryczne, generatory.

Introduction

Since laptop computers and mobile power widely used, the traditional batteries have been impossible as power sources. The rechargeable batteries are current technology mainly for energy of mobile equipment[1]. But with the progress of the times and the improvement of human life, litter, deft and high-capacity generator is required in human health monitoring, environment monitoring, internet, military applications and so on, therefore seeking weighs less portable power supply becomes more and more important [2]. In the future, micro/nano-system technology will be widely used[3].

In 1880, Pierre Curie brother found some crystals have the piezoelectric effect, in their shape change produced current and was energized then could produce the deformation[4]. In 2006, Wang Zhonglin professor in Georgia Institute of Technology, who had found nanoscale piezoelectric materials in deformation could release energy, and used nanometer ZnO fiber piezoelectric materials to produce the smallest generators[5-7]. This paper will introduce working principle about how to manufacture three-phase nanogenerator and piezoelectric nanogenerator under ambient vibration, and manufactures three-phase nanogenerator and piezoelectric nanogenerator under vibration, and studies their performances also. All of the purpose is to establish a foundation for widely using of future research about micro/nano-system technology.

Experiment

A. Materials

Nano-copper, nano-iron, nano single-walled carbon nanotubes, nano metallic conductors, insulation paint, metal platinum piece, ZnO nanorod, anhydrous alcohol, polymer silicone, fast quenching NdFeB magnets(20-50nm), BaTiO₃ insulation paint(80nm), carbon fiber, milli-tile voltmeter, micro ammeter, oscilloscope, VHx-900 super preview digital microscope.

B. The manufacture of three-phase nanometer generator

20-50nm fast quenching sintering NdFeB permanent magnet is used as N, S very, electric brush and sets electric ring for nano copper constitute coil are connected with the materials of three -walled carbon nanotube by 120 degrees angle, carbon nanotube is fixed on nanometer iron tube which is as core. Vibrations rotating rods are made of carbon fiber bar, it's working principle is similar rotate mop. The manufacture of three-phase nanometer generator

under vibration and it's circuit determination are shown in Fig. 1-3 :

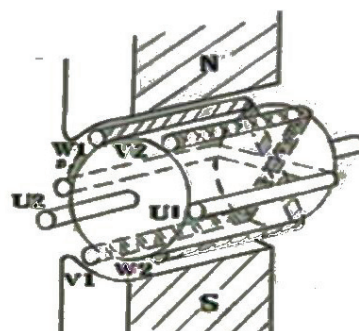


Fig. 1 Three-phase micro vibrations nano generator

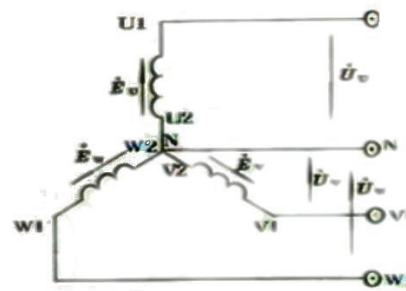


Fig. 2 Three-phase micro vibrations nano generator circuit

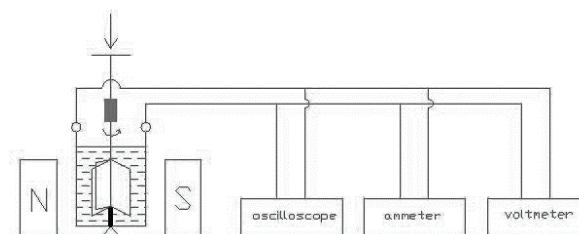


Fig. 3 Three-phase micro vibrations nano generator circuit determination schematic

C. Piezoelectric material preparation

Nanoscale piezoelectric materials can release power in deformation. Using this principle, we plant the vertical growth of ZnO nanorod array on a composite material which is made of a quick elastic platinum chip/polymer layer (platinum chip is made to be jagged). The process is as follows: a conical ZnO nanorod will be cut off from substrate and put into ethanol solution, then this ethanol solution that contains ZnO nanorod will be dropped in a tiny metal electrode and a platinum chip/polymer layers. After ethanol solution all being evaporated, there will appear a new layer of nanowires layer, finally use two level platinum chip/polymer to form a kind of composite piezoelectric materials(1 square cm) [8]. See Figs. 4, 5.

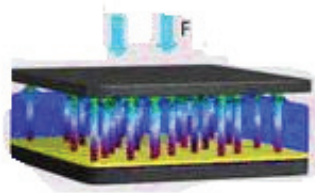


Fig.4 Piezoelectric material amplification schemes



Fig.5 Piezoelectric material schematic

Table 1 Three-phase vibrations nano generator performance parameters

Project	First determination	The second determination	The third determination	Average	Explain specifications
Rated voltage (μV)	12	11	12	10	10
Rated current (μA)	4.0	4.0	4.0	4.0	4.0
Rated power (μW)	62	60	62	61	60
Power factor	0.85	0.82	0.88	0.85	0.85
Frequency (HZ)	54	48	52	51	50
Weight (mg)	5.8×10^{-4}	5.9×10^{-4}	6.0×10^{-4}	5.9×10^{-4}	6.0×10^{-4}
Envelop dimensions (LxBxH) μm	90x76x125	91x76x123	90x75x126	90x76x125	90x75x125

Table 2 The current, voltage and power of nanobattery under vibration in press and change electric field

Project	First determination	The second determination	The third determination	Average	Explain specifications
Nominal voltage (μV)	100	110	108	106	105
Current rating (nA)	50	48	52	50	50
Power (μW)	8	7	9	8	8
Power factor	0.85	0.88	0.83	0.85	0.85
Frequency (HZ)	54	48	52	51	50

Table 1 shows, the voltage and no-load current and no-load power of three-phase nanometer generator are also small, and its power factor is also slightly higher than traditional three-phase generator. But its frequency is 50 HZ. The material of generator is different, so the performance of three-phase vibration nanogenerator is

D. Manufacture of piezoelectric nanogenerator

The N and S pole is produced by fast quenching Neodymium–Iron–Boron permanent magnets (20-50nm), the collector ring is constituted by nano copper, the vibrobatten for piezoelectric material elastic plate and is wound by nano copper laps, the fixed holder is made of carbon fiber. Both copper laps and piezoelectric materials under vibration can generate electricity[7-8]. Its work and measuring circuit are showed by Fig.6.

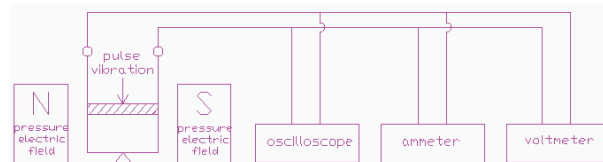


Fig.6 The circuit determination schematic of piezoelectric nanogenerator under vibration

Results and discussion

A. The performance measure of three-phase vibration nanogenerator

Using VHx-900 super preview digital microscope, in 1500 times, the three-phase vibration nanogenerator is observed and weighed. According to three-phase permanent magnet synchronous motor test method "Test procedures for three-one phase synchronous machines to highlight (GB/T 22669-2008)"[8], the three-phase vibration nanogenerator is tested. In vibration pulse 30 times/points (500 R.P.M.), it is discovered that the oscilloscope trace is expressed as a three positive XuanBo. The parameters of voltage, current, and power etc are shown in Table 1.

superior than conventional generators. It is compared to weight by three-phase vibration nanogenerator and traditional one, the latter is great heavier than the former, just like their size. It is found that there is more high voltage, no-load current and no-load power by series-parallel connection of many three-phase nanometer generators.

B. The performance measure of piezoelectric nanogenerator under vibration

Use a VHx - 900 super preview digital microscope (in 2000 times) to observe the situation of ZnO nanorod piezoelectric materials deformation. According to vibration pulse (30 times/points) demonstration, the oscilloscope show diphasic and sinoidal, waveform is big and small. Voltage, current and power all showed by Table 2.

Table 2 shows that Piezoelectric nanogenerator under vibration has less voltage, current and power, the rated current only 50 nA, rated voltage power 105 μ V, power 8 μ W, but power factor reach to 0.85, all of these can demonstrate that generating efficiency is high. Observed the oscilloscope waveform, in ambient vibration condition, piezoelectric materials produce larger rated current and voltage. However, copper laps cutting magnetic line of force produce less rated current and voltage. So the piezoelectric nanogenerators can be separately used to supply power. If multiple piezoelectric nanogenerator in tandem may produces higher voltage, current and power. But because piezoelectric materials have large surface area, if multiple piezoelectric nanomaterials be series, surface area may reach to several dozens of square centimeters, however, this kind of generator only suitable for large surface area, such as underground sidewalk, platform bridge and stair tread etc, the piezoelectric nanomaterials laided in the next can lighten road lamp.

Conclusions

The paper introduces the working principle about two nanogenerators under ambient vibration, and two nanogenerators are produced, their performance are studied also, the results show that:

(1) On the basis of the working principle of generator and the present nanomaterials, three-phase nanogenerator can be prepared. The voltage, no-load current and no-load power of three-phase nanometer generator are small, but its power factor is slightly higher than traditional three-phase generator. The strong point of three-phase

nanogenerator is smaller weight and size. It is found that there is higher voltage, no-load current and no-load power can be got by series-parallel connection of many three-phase nanometer generators.

(2) The piezoelectric nanogenerators can be prepared using nanoscale piezoelectric materials can release electric power. In ambient vibration condition, piezoelectric materials can produce larger rated current and voltage. Duo to less rated current and voltage are got for copper laps cutting magnetic force line, so the piezoelectric nanogenerators can be separately used to supply power. There is more high voltage, current and power by series multistage of many piezoelectric nanogenerators. Another advantage is it can be made in large acreage and lightweight.

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