An Analysis of the Concentration and Properties of Negative Ions Emitted by Incrediwear Fabric

Background

The semi-conductor elements embedded into Incrediwear fabric emit infrared waves and negative ions. Both infrared waves and negative ions are biologically active and have been shown to increase blood flow and velocity, mediate anti-inflammatory nitric oxide production, protect muscle damage, scavenge reactive oxygen species, among other physiological benefits[1,2,3,4]. The purpose of this analysis is to determine the concentration of negative ions Incrediwear fabric emits and the effectiveness of that concentration in modulating anti-inflammatory and pain pathways.

Negative Ions and Their Properties

Air Ions are atoms or molecules in the atmosphere that are electrically charged. Negative air ions (NAIs) are atoms or molecules that have gained an electron, thus leading to a negative charge. The energy sources that often provide air ions are naturally occurring and include cosmic rays, sunlight, wind, plants, thunder, and lightning. Ions can also be produced by the breaking of water droplets, which increases their concentration near the seashore or waterfalls[5].

There has been a growing body of evidence that supports the physiological benefits of negative ions[5]. Several studies have shown the exposure of NAIs alleviate symptoms of depression, seasonal affective disorder[6], and improvement in cognitive performance tasks[7]. There have also been studies on the effects of NAIs on increasing aerobic metabolism and improving the cardiovascular system[8].

The properties of negative ions that is of most importance to the therapeutic modality of Incrediwear is their antioxidant and anti-inflammatory properties. NAIs scavenge for reactive oxygen species and neutralize free radicals. This greatly diminishes the presence of oxidative stress and inhibits inflammatory and pain pathways to promote increased healing and oxygenation to the affected area[9].

Incrediwear Fabric: Germanium and Bamboo Carbonized Charcoal

The semi-conductor elements embedded into Incrediwear fabric are germanium and bamboo carbonized charcoal. Germanium has 4 unpaired electrons moving irregularly around the nuclei. When it is exposed to temperatures above 32°C (86.5°F) or any changes in atmospheric pressure, one of the unpaired electrons escapes from its orbit and produces a negative electron. The surrounding air ionizes with a negative charge, thus producing negative air ions. Since the human body temperature is at 36.5°C (97.7°F), the germanium present in Incrediwear fabric emits negative ions when it is worn. A negative ion is also produced by germanium via piezoelectricity. If the fabric is in friction with the skin while moving or in contact with another object, NAIs will also be produced[10].

Bamboo carbonized charcoal is created by heating up bamboo to over 800°C. The resulting charcoal has a high porosity and large inter-particulate surface area, which is ten times that of regular charcoal. The excellent adsorbent properties of bamboo charcoal have guided several

studies to study the filtration and purification of air, wound healing capabilities, and anti-microbial use cases[11]. Bamboo charcoal has also been shown to generate negative ions and far infrared radiation[12], which in combination with germanium, provides the therapeutic benefit of Incrediwear fabric.

Testing Methods and Design

The negative ion concentration of Incrediwear Cred38 fabric was tested at Hua Mao Nano-tech located in Taiwan. They utilized the ITC-403A negative ion measurement system which is a dynamic friction test machine[13].

Dynamic Friction Test Machine

The dynamic friction test machine is an enclosed chamber that has an ambient temperature of 20℃ (68°F), relative humidity of 65%, and pressure of 995 hPa, which are all optimized to provide a controlled and ideal environment (Appendix 1). A schematic of the dynamic friction test machine is shown in figure 1[10]. A small piece of Cred38 fabric is placed onto the friction disk and the track spins the disk to generate friction on the garment. The piezoelectricity property of germanium and bamboo charcoal releases negative air ions into the enclosed chamber. The produced NAIs then travel through the air tube to the negative air ions tester, where the final value of NAIs is displayed[10]. This test is repeated four more times and the average range of NAIs produced by Incrediwear fabric is achieved through numerical analysis (Appendix 1).

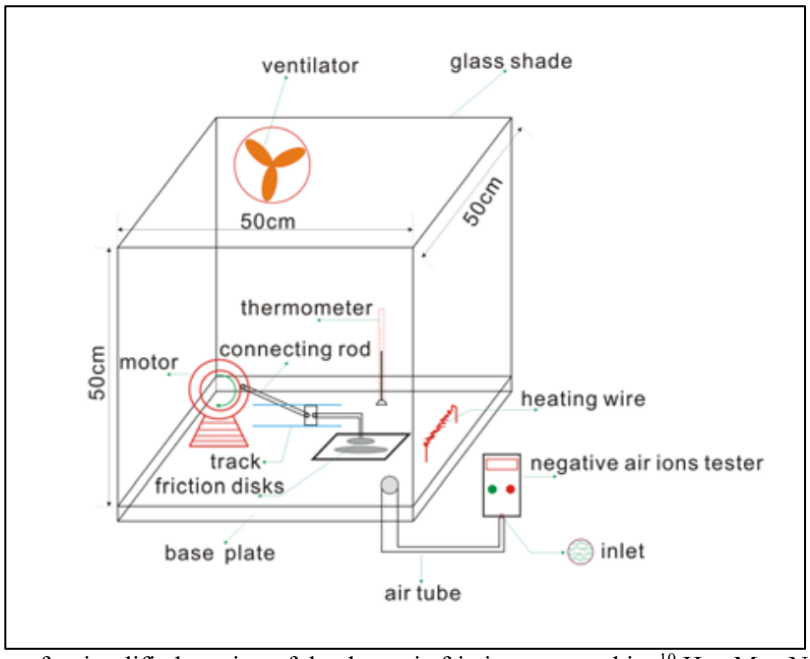

Figure 1. Diagram of a simplified version of the dynamic friction test machine[10] Hua Mao Nano-Tech uses to conduct negative ion measurement analysis on Incrediwear fabric.

Negative Air Ions Tester: Gerdien Condenser

The negative air ions tester measures the amount of NAIs produced via a Gerdien condenser, as shown in figure 2[14]. This condenser is made up of two coaxial electrodes, with an outer electrode that is a hollow cylinder, and an inner electrode, that is a solid wire. The configuration of concentric tubes has finite capacitance, which is derived from Gauss's Law. Air flows through

the tubes and pushes the NAIs in the space between both electrodes. As a potential is applied to the electrodes, the NAIs are attracted to the inner electrode and repelled from the outer electrode. When the NAIs are on the inner electrode, a current is produced and that is proportional to the negative ion concentration of the air[14].

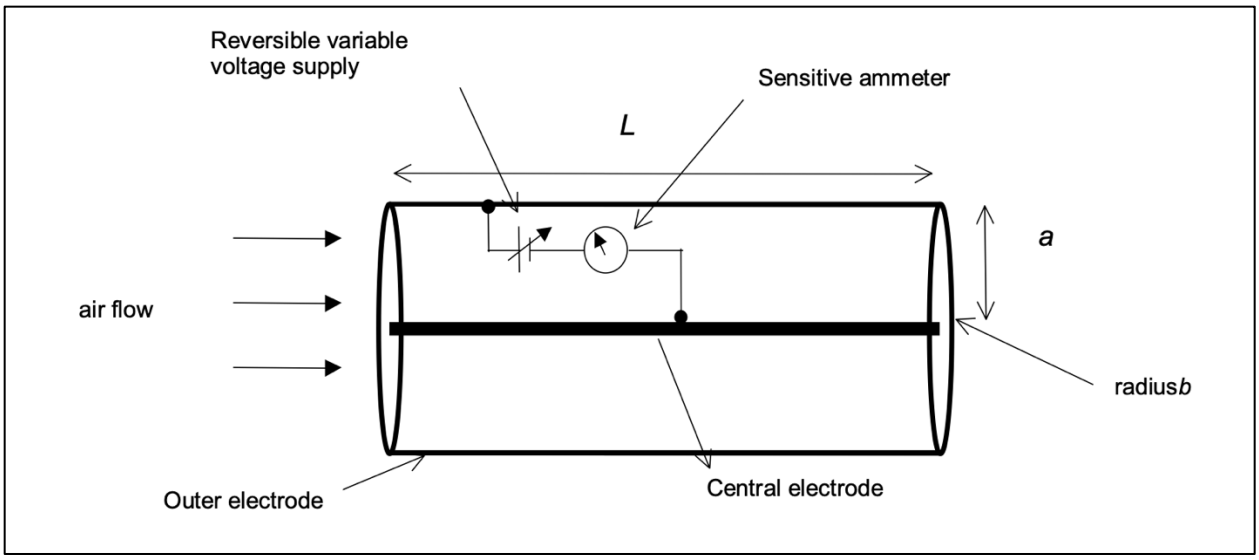

Figure 2. A schematic diagram of a Gerdien Condenser, which is located in the negative air ion tester[14].

The following equations explain this process mathematically[15]:
Air flow rate (∅) is given by,

$$\emptyset = \nu\, \pi(r_a^2 - r_b^2)$$

Where ν, is the mean value of velocity measured with a velocity meter, r_a is the radius of the outer cylinder, and r_b is the radius of the inner cylinder.

The negative air ion concentration (N) is given by,

$$N = I / (e\, \emptyset)$$

Where I is the input current and e is the charge of an ion ($1.6 * 10^{-19}$ C).

Data Analysis and Discussion

According to the measurement analysis report from Hua Mao Nano-Tech, the Cred38 fabric produced a negative ion range of 1730 – 2405 (ions/cm^3) (Appendix 1). This value was acquired from the piezoelectricity property, or friction, of the fabric. However, it is unknown if the ambient temperature of the dynamic friction test machine increased past 20℃. This is an important piece of data that is missing. Since germanium must pass the temperature threshold of 32℃ to release NAIs, it is imperative that the testing accounts for this threshold to be met[10]. The negative ion range of 1730-2405 (ions/cm^3) will sharply increase if the test was held at or above 32℃. Ideally, the test is run at 36.5℃, the average temperature of the human body, to get the most accurate measurements.
Despite the uncertainty of temperature within the machine, 1730-2405 (ions/cm^3) of NAIs is still a therapeutic range. According to several clinical trials focusing on the physiological benefits of

NAIs, a concentration of over 2000 (ions/cm^3) is enough to produce statistically significant results. In a double-blind study by Ho, C. et al., thirty-eight badminton players were randomly assigned to receive 0, 300, 3000, and 30,000 (ions/cm^3) of NAIs post exercise. The 3000 and 30,000 levels of NAIs alleviated exercise induced muscle damage and significantly decreased TNF-α, creatine kinase, and lactate dehydrogenase[16]. Similarly, in a study by Wallner, P. et al., twenty healthy adults had exposure to 2194 ions/cm^3 NAIs for 2 hours. They found a statistically significant increase in cognitive ability and sympathetic ability[17]. Cardiovascular benefits were also seen by NAIs in a study by Mao, GX. et al., where twenty-four elderly patients where either sent to an evergreen forest or a city area for seven days. The group located in the forest received an average NAI concentration of 1838 ions/cm^3 per day and had a significant reduction in blood pressure and inflammatory cytokines such as IL-6 and TNF-α[18]. Figure 3 below is a visual representation of the exposure time and NAI concentration in the above-mentioned studies, including others, and how Incrediwear fabric compares.

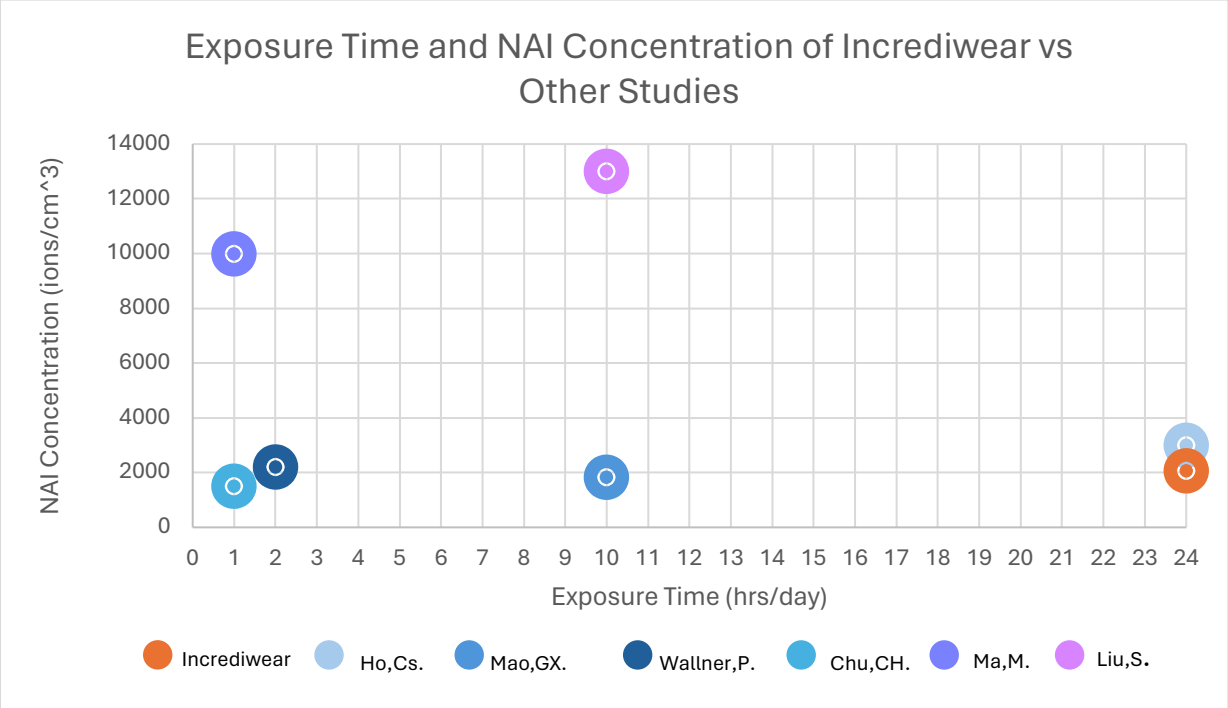

Figure 3. Incrediwear NAI concentration vs other studies with statistically significant therapeutic results. Ho, Cs. Et al studied muscle damage and inflammatory markers in badminton players[16]. Mao, Gx. Et al studied the cardiovascular benefits from NAIs in a forest in the elderly population[17]. Wallner, P. et al found an increase in cognitive ability from NAIs[18]. Chu, CH. Et al found an increase in information processing in a study with thirty-nine adults[19]. Ma, M. et al found increased blood lipid indicators in a study with fifty-six hyperlipidemia patients[20]. Liu, S. et al studied NAIs benefits on the respiratory function in forty-four patients[21].

The wide range of exposure time and NAI concentration from previous studies indicates that once the 2,000 ions/cm^3 NAI concentration threshold is met, there are likely to be physiological benefits[22]. The published studies mentioned above also suggest that an increase in NAI concentration correlates with an increased beneficial effect[16,17]. Incrediwear Cred38 fabric emits similar concentrations to clinical trials with statistically significant results, thus implying that it is in the therapeutic range. However, as mentioned before, if the fabric is tested at body temperature (36.5℃), then there is a high likelihood there will be an increase in NAIs emitted by

Incrediwear. Further negative ion emission data needs to be collected for the most accurate understanding of Incrediwear fabric.

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Appendix 1: Incrediwear Fabric Test Reports from Hua Mao Nano-Tech

華楙生技股份有限公司
Hua Mao Nano-Tech Co., Ltd.

試驗報告
Test Report

正　本
ORIGINAL

日期 Date：112.09.22　收件日期 Date of Receipt：112.09.14

報告編號 Report No.：HMT-ITC-221918　數量 Quantity：1　報告頁次/頁數 Page Order/Pages：2

報告抬頭 Report Title：Incrediwear Holdings Inc

地址 Address：180 East 4th Street, Suite 120 | Chico, CA 95928

Negative Ion Measurement Analysis Report

Source of samples: Incrediwear Holdings Inc

Test Results and Descriptions

A. Test results

Sample	Negative Ion (pcs/cc)	Positive Ion (pcs/cc)
Cred38 Fabric	1730-2405	250-350

B. Test Descriptions

1. Test method

By way of friction between testing materials , negative and positive ions are generate and counted by ITC-403A based measurement system.

2. Test Instrument

Negative Ion measurement system (ITC-403A) . Serial number:3050006

3. Environmental condition

Pressure : 995±5 hPa

Time period : Equilibrium state 10 min

Grounding conditions : Surface resistance of sample is less then 1 MΩ

Ambient Templerature : 20 ± 1℃

Relative Humtidity : 65%

4. Sampling Procedure

The test samples were repeated more than 5 times the detection value obtained by numerical analysis.

Notes:

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3. The report data, correct the invalid.

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