# Filling MWCNTs to make water-lubricated bearings intelligent

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This study aims to investigate experimentally the preparation and application of a self-sensing composite material used for water-lubricated bearing. The high-density polyethylene (HDPE) possessed both tribological and sensing properties by filling multiwalled carbon nanotubes (MWCNTs). The results showed that MWCNTs obviously reduce their coefficients of friction (COFs) and improve thermal conductivity. The stress and wear volume of their structure can be analyzed with electrical resistivity monitoring. The tribology and conductive theories of the composites were revealed. The challenges were finally discussed in the development and application of intelligent water-lubricated bearings.

**Keywords (from 3 to 5 max):** tribology, water-lubricated bearings, carbon fillers, friction reduction, self-sensing

## 1. Introduction

Water-lubricated bearings are critical components of the marine propulsion system. There are still a number of ship accidents caused by their faults. Condition monitoring during operation is essential to take reasonable actions before accidents. However, a traditional structural health monitor is not suitable under the water environment. Adding MWCNTs into cement matrix to make self-sensing cementitious composite has been researched since the 1990s [1]. Meanwhile, adding MWCNTs has also been proved that can dramatically enhance the tribology performance of water-lubricated bearings [2]. Therefore, it is reasonable that MWCNTs can make water-lubricated bearings self-sensing with tribology property improvement, which can solve the problem of underwater environment monitoring.

## 2. Methods

Firstly, MWCNTs and HDPE were melted blending. Then composites were formed together with thermocouples and electrodes by hot-press processing. After that, frictional tests were conducted (Figure 1).

During the frictional test, pressure, speed, torque, and other parameters are collected continually in real-time, and the following equation calculates the COF.

$$\mu = \frac{T}{r \times F} \quad (1)$$

where μ is the COF, T (N·m) is the friction torque, r (m) represents the rotation radius, and F (N) indicates the applied load.

To simulate the real working condition, four tests were conducted underwater with two different loads and speeds. Two other tests were also conducted in a dry condition for accident simulation.

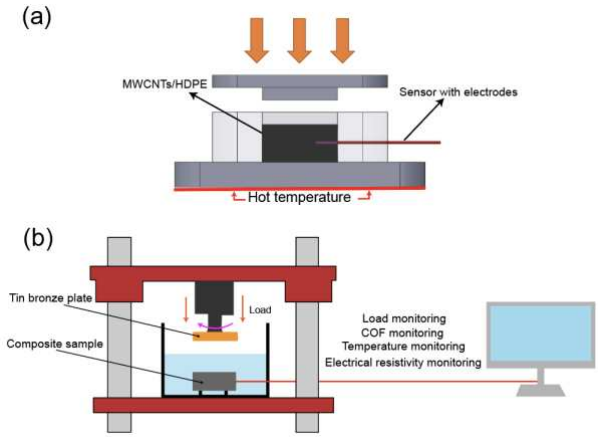


Figure 1: Experimental materials and apparatus: (a) preparation of MWCNTs/HDPE composites (b) frictional testing

## 3. Discussion

According to the results from frictional tests, the MWCNTs/HDPE composite has better tribology performance and thermal conductivity, with low average COFs and temperature. The Load, COF, temperature, and electrical resistivity data during tests were helpful to develop an automatic program that is able to continually evaluate the condition of the composite sample. This study was conducted as the early research of the intelligent water-lubricated bearings. Monitoring water-lubricated bearings will be achieved by more sensors embedded and advanced programs with similar approaches.

## 4. References

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