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Development and Applications of Triboelectric Sensors in the Industrial Technology

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Abstract

With the increasing demands for high mobility, wide distribution, and wireless operation of modern sensors, it is inevitable to develop new self-powered smart sensing technologies. Triboelectric nanogenerator (TENG) based on the coupling effect of triboelectrification and electrostatic induction was first invented by Wang's group in 2012 [1]. TENGs are a field that uses Maxwell's displacement current as the driving force for converting mechanical energy into electric power/signal [2-4]. Herein, a self-powered sensing method for the modern industry has been proposed. In particular, a range of triboelectric sensors are designed for the common mechanical motion sensing and fluid state monitoring requirements. For the industrial technical requirements, a series of triboelectric mechanical motion sensors, such as the linear motion triboelectric position sensor, the highly integrated triboelectric smart bearing, the triboelectric rotary motion sensor, are proposed for speed detection and real-time direction monitoring. The sensors have realized the intelligent and low-cost manufacturing of mechanical equipment motion sensing. Besides, for the fluid measurement, a novel wave coupling method is first proposed, which reveals that liquid-solid electrification realizes flow sensing. Simultaneously, a sequence of triboelectric flow sensors with a built-in float structure that can be used for gas or liquid measurement are invented. The comparison verifies that its output performance is identical with that of commercial sensors. In addition, the vibration sensor is one of the most widely applied sensing technologies. A novel double-spring-piece structured triboelectric sensor is proposed for broadband vibration real-time monitoring and warning. The sensor can achieve vibration frequency measurement in the range of 0~200 Hz with high linearity, and the error rate is less than 0.015%. These researches can effectively promote the development and applications of self-driving sensing technology in the field of smart machinery.

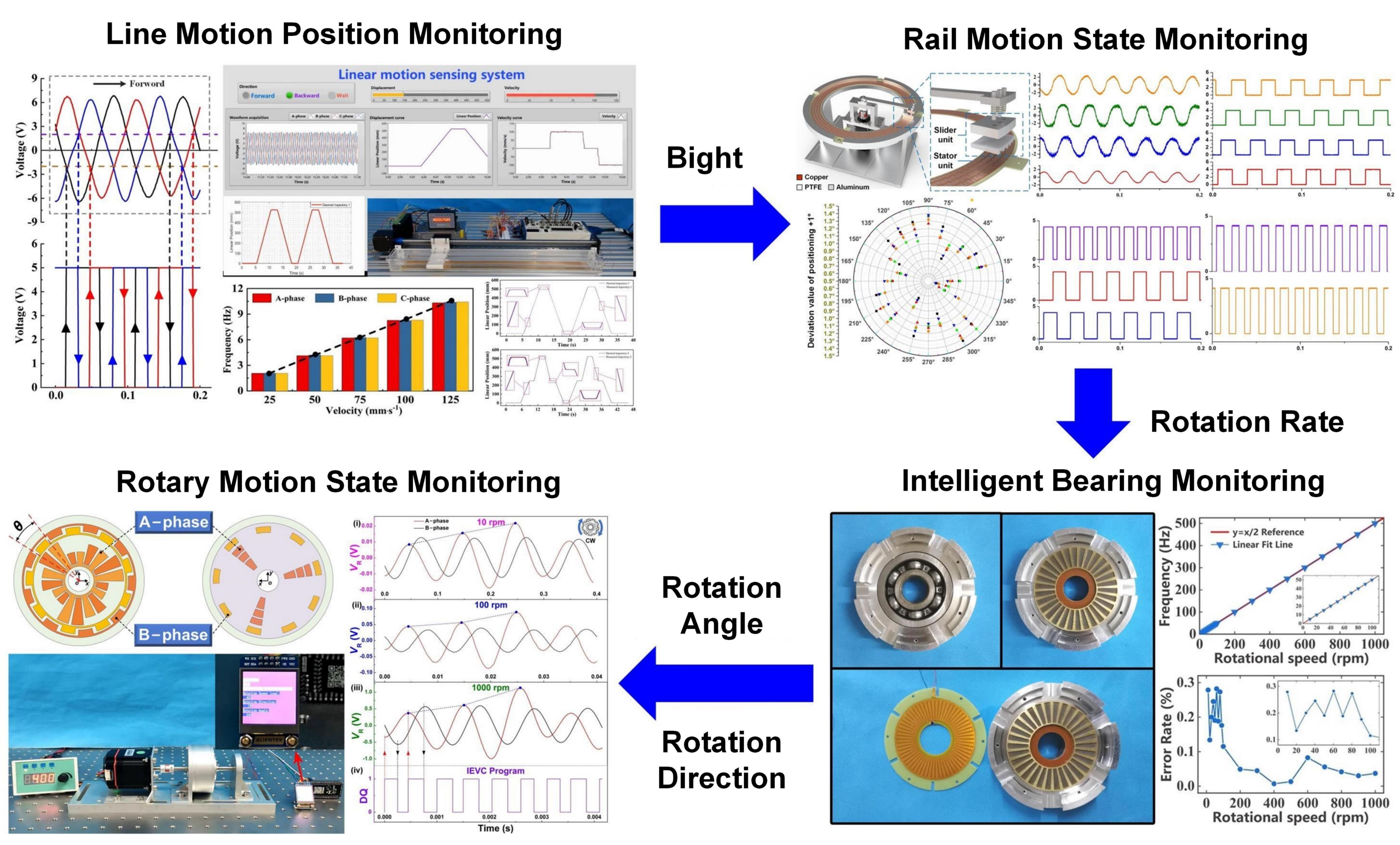

Figure 1. Series triboelectric mechanical motion sensors [5-8]

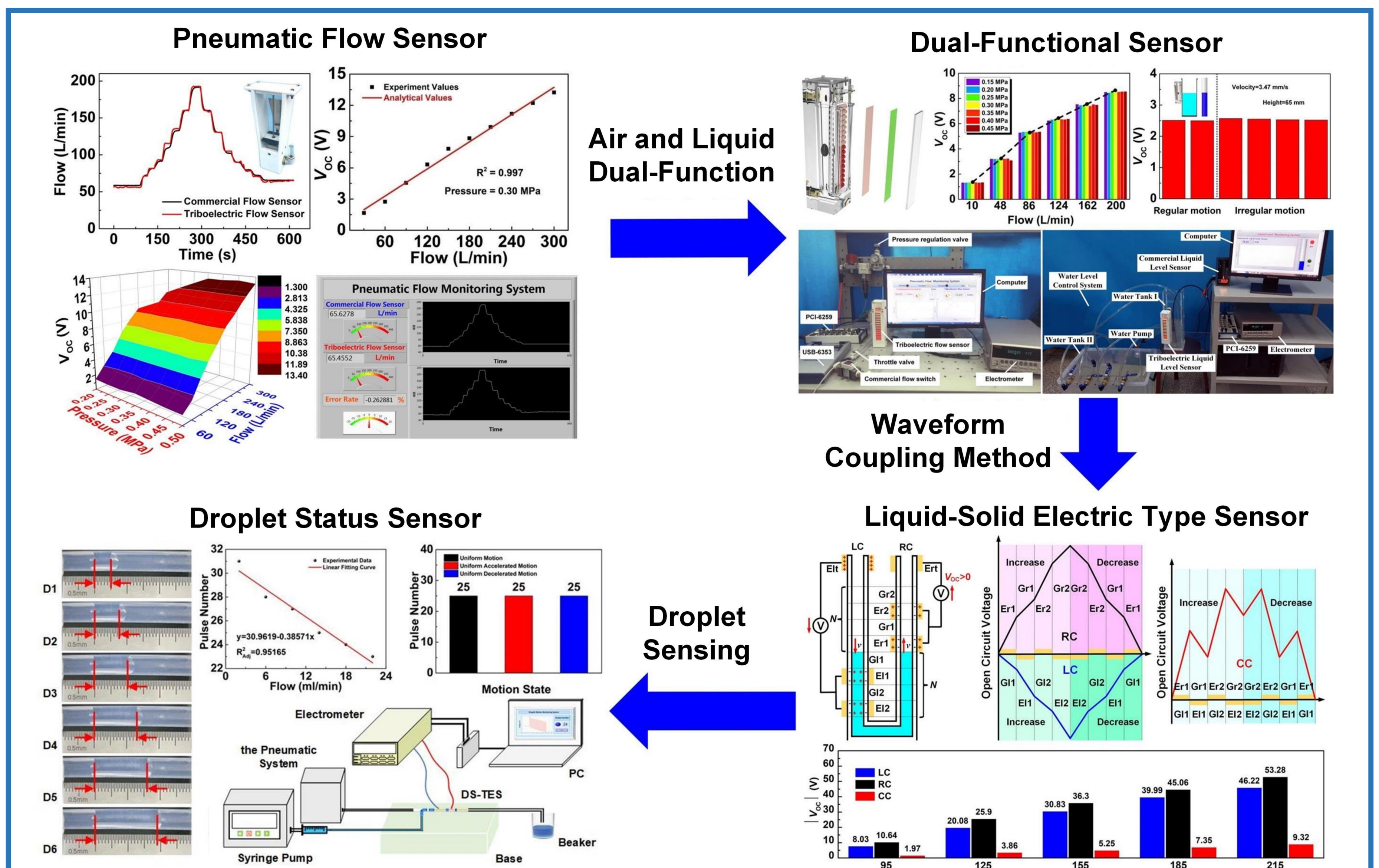

Figure 2. Series triboelectric fluid condition monitoring sensors [9-12]

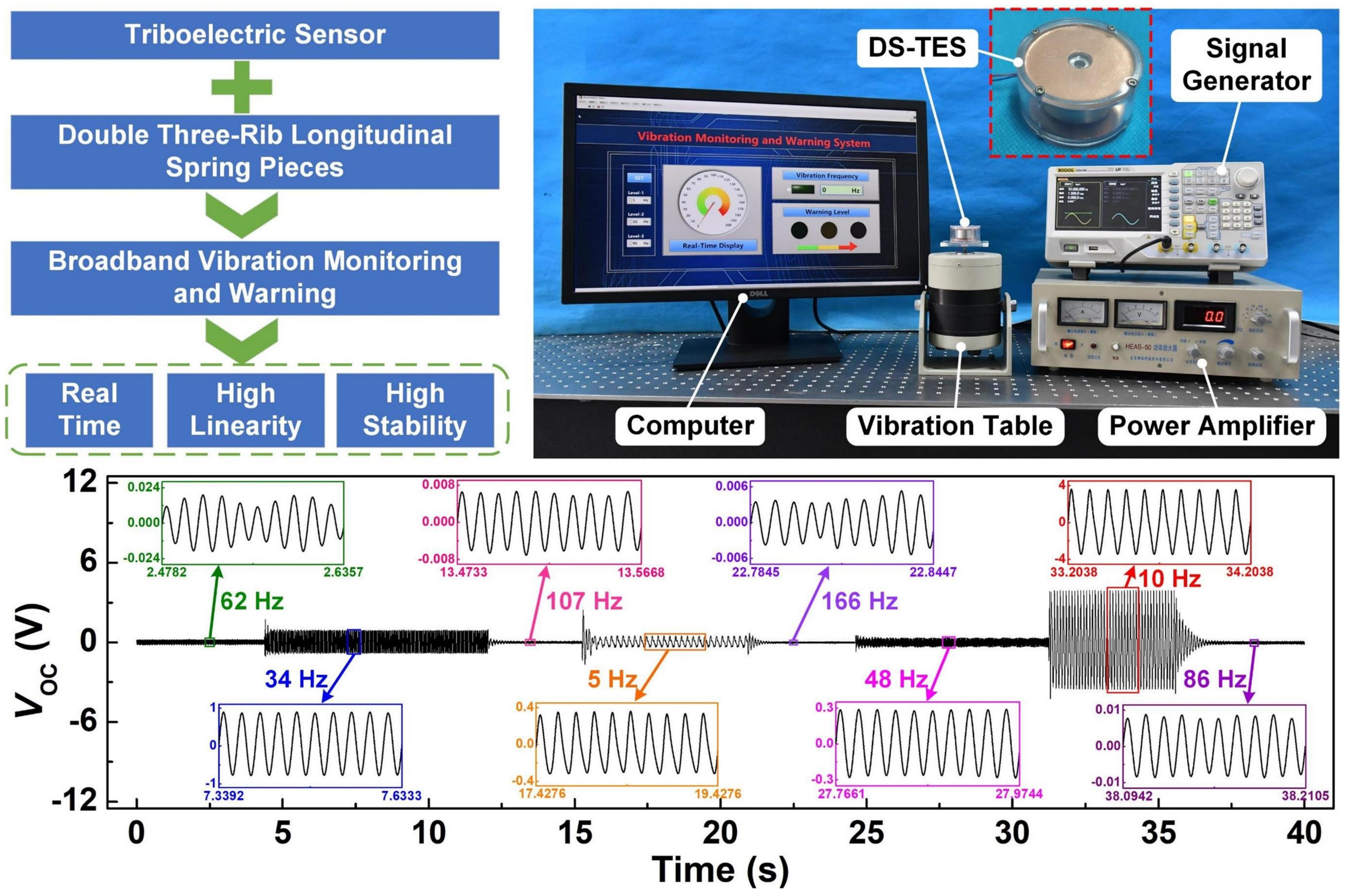

Figure 3. Triboelectric vibration monitoring sensor [13]

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