

Piezoelectric Paper: A Study on Effect of Fiber content on Mechanical and Electro-mechanical Properties

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Introduction

- Piezoelectric papers are cost-efficient, flexible, and environmentally friendly materials and widely used in sensors including:
 - Strain sensors [1]
 - Gas sensors [1]
- Piezoelectric response** determines the sensors' accuracy. **Stiffness** characterizes the sensors' deformation under forces.
- Piezoelectric papers' two main fiber contains:
 - Pulp**: the main material for the fiber network.
 - Fines**: improve mechanical strength
- Research gap in how pulp and fines impact piezoelectric papers' performance

Objective

- Study the fiber content and fines' effect on piezoelectric papers' stiffness and piezoelectric response is explored.

Methods

Step 1: Piezoelectric Paper Fabrication

- Step 1.1:** Fabricate 8 paper samples using different amount of pulp and fines (Table 1)
- Step 1.2:** Anchor BaTiO₃ particles to fiber network through layer-by-layer processing (Figure 1).
- Step 1.3:** Pole the hybrid papers based on BaTiO₃'s curie temperature (122°C) to render paper with piezoelectricity.

Results

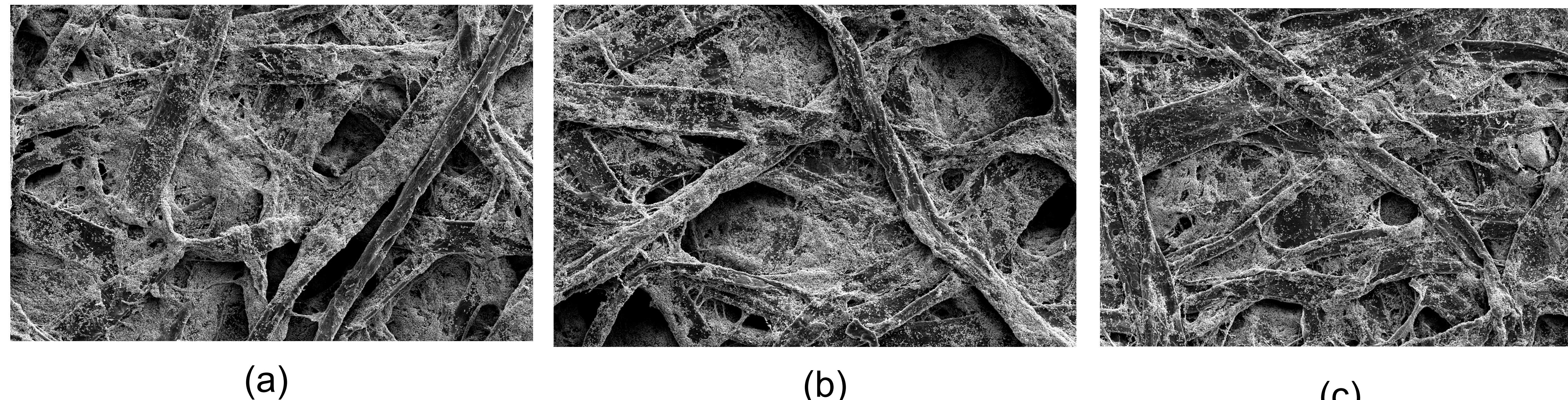


Figure 2: SEM images of a paper composite with different amount of pulp. (a) 300 mL, (b) 400 mL, (c) 500 mL.

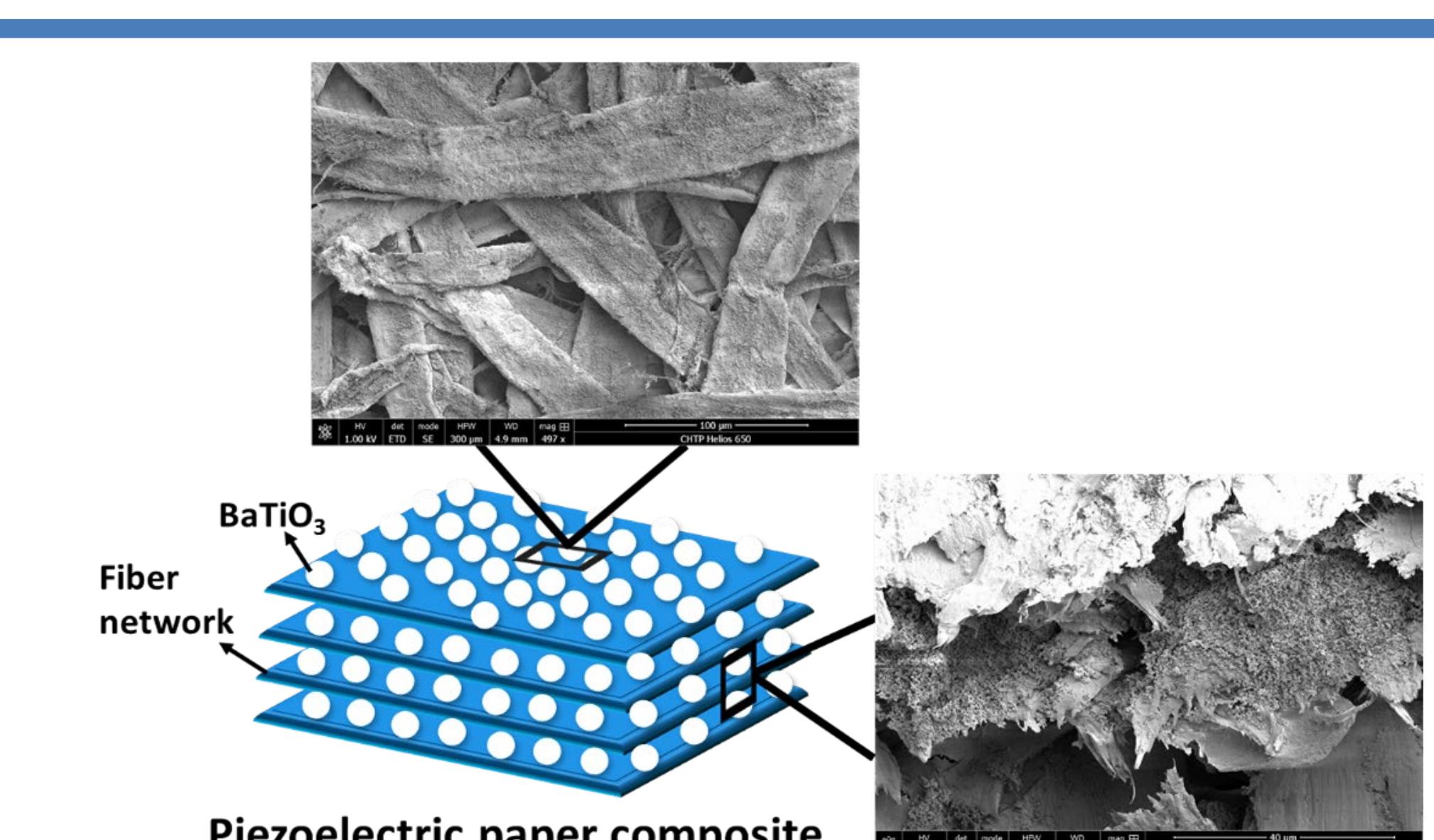


Figure 1: Scanning electron microscopic(SEM) images of BaTiO₃ particles anchored to the fiber network

Table 1: Paper with different amount of pulp and fines

Paper	A	B	C	D	E	F	G	H
Pulp [mL]	300	400	500	600	700	400	400	400
Fines [mL]	0	0	0	0	0	25	50	75

Step 2: Paper Characterization

- Step 2.1:** Material characterization by **Scanning electron microscopy (SEM)**
- Step 2.2:** Testing compressive modulus of the paper by **Dynamic mechanical analysis (DMA)**
- Step 2.3:** Measurement of piezoelectric coefficient (d33) by d33 meter.

Discussion

- Reveal the fiber amount and fines' effect on stiffness and piezoelectric response.
- Compressive modulus increase with the amount of pulp.
- Piezoelectric constant increases with the amount of fiber until reaching its peak.
- Future works:
 - Analyze the fibers' effect on electro-mechanical coupling factor and Dielectric constant.
 - Correlate piezoelectric constant to other electro-mechanical properties.

Reference

- 1.S. K. Mahadeva, K. Walus, and B. Stoeber, "Paper as a platform for sensing applications and other devices: A Review," *ACS Applied Materials & Interfaces*, vol. 7, no. 16, pp. 8345–8362, 2015.

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