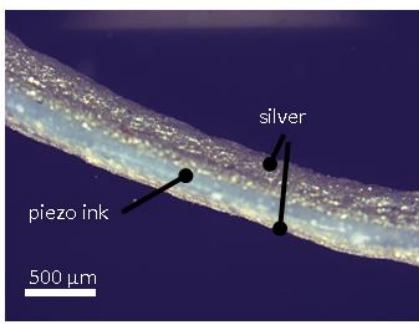




## Additive manufacturing of piezoelectric sensors



### Background

Piezoelectric materials and sensors are very popular among almost every industry. But, both these materials and their fabrication process also face important challenges. PVDF (polyvinylidene fluoride) is the mostly used polymer in the piezoelectric industry. It has the advantage to be compliant, easily printable and flexible (unlike ceramics that are very brittle). However, this polymer does not possess piezoelectric properties naturally. It must undergo heavy post processing transformations to acquire them (like poling). These operations often require several hours as well as high temperature and electric current. Additionally, piezoelectric elements have to be connected to electrodes in order to become operational sensors. This inter-connection is particularly difficult to realise when it comes to complex or small sensors. Additive manufacturing (also referred to as three-dimensional (3D) printing) consists of joining materials to make complicated objects from a 3D computer-aided-design (CAD) model in a layer-by-layer fashion. It allows the fabrication of complex shapes and on demand sensors but requires a precise method and process control to be really efficient.

### Technology

Professor Therriault and his team have mastered these challenges by developing an innovative technology. Barium titanate ( $\text{BaTiO}_3$ ) well known for their piezoelectric properties were dispersed in PVDF in his natural phase (hence not inherently piezoelectric). This dispersion technology relies on a mixing method. This method enables a nanoparticle distribution very superior to the usual mixing techniques. Thus, the final composite can reach a piezoelectric coefficient of about  $18 \text{ pC.N}^{-1}$  (comparable to the commercial PVDF) but without any post transformation process required. One step sensor fabrication is done by co-extruding both piezoelectric ink and silver paste used as electrode. The viscosity of both these components is strictly controlled to allow the ink and its electrode to be interconnected with no risk of delamination.

### Application

This invention is particularly useful in sectors where custom sensors are necessary: for instance biomedical and robotics. Others applications are foreseen in the 3D printing industry where the one step fabrication piezoelectric ink and sensor is a time and cost effective advantage.

### Competitive Advantages

- No heavy post transformation process required
- Versatile ink adapted to large industrial fabrication companies and individual 3D printing
- Ability to form complex shape sensors on demand
- Cost effective and time saving technique

### Patent

US Provisional Patent Application

### Next Steps

One of the next steps is to produce piezoelectric yarns and films avoiding the poling steps, thereby, simplifying the present fabrication techniques.

### Contact

Audrey Somé, M. Sc. A  
Project Leader, Sciences and Engineering  
Business Development  
Univalor  
+1 (514) 340-8524  
[audrey.some@univalor.ca](mailto:audrey.some@univalor.ca)

Daniel Therriault, Ph.D.  
Professor  
Department of Mechanical Engineering  
École Polytechnique de Montréal  
+1 (514) 340-4711 ext 4419  
[daniel.therriault@polymtl.ca](mailto:daniel.therriault@polymtl.ca)

