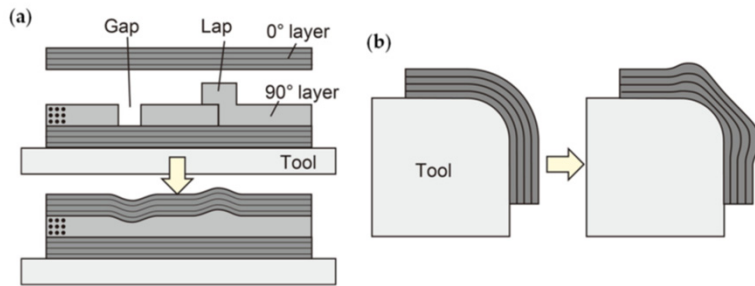


# Embeddable Fiber-optic-based Shape Sensor for In-situ Consolidation Monitoring

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## 1. Consolidation

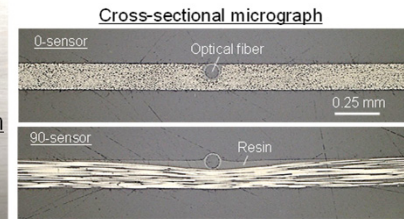
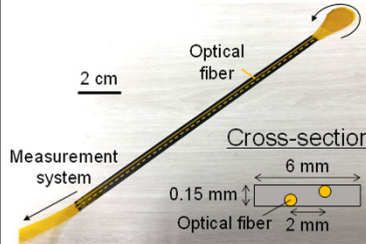
Resin is liquid state and viscosity decreases as temperature increases...  
Resin and fiber suspension flows, and **composite shape is distorted**



No technology existed to measure consolidation deformation under hot and high-pressure condition during composite curing

## 2. Strip-type shape sensor

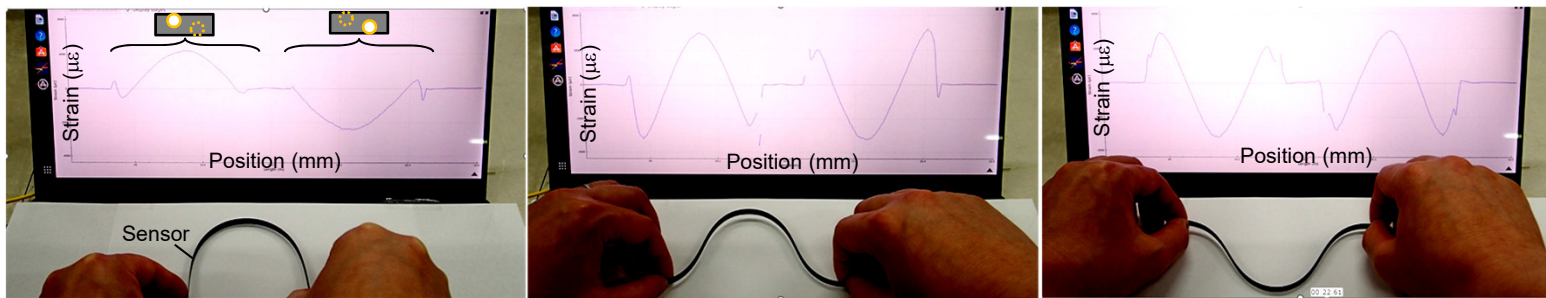
S. Minakuchi et al., *Sensors*, 22, 17: 6604 (2022)



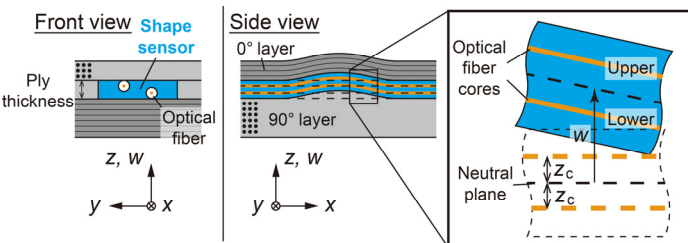
- ✓ One ply of cured carbon/epoxy prepreg is used as thin, flexible sheet
- ✓ Sensor can be embedded without changing thickness of composite part by replacing prepreg in sensor embedding area with sensor there
- ✓ When bended, different strain (bending strain) is induced in two optical fiber, and shape can be calculated by integrating strain difference

## 3. How does sensor work?

- ✓ Spatial resolution < 1 mm, Sampling interval > 1Hz
- ✓ Sub-mm deformation in mm-range area can be measured in real-time

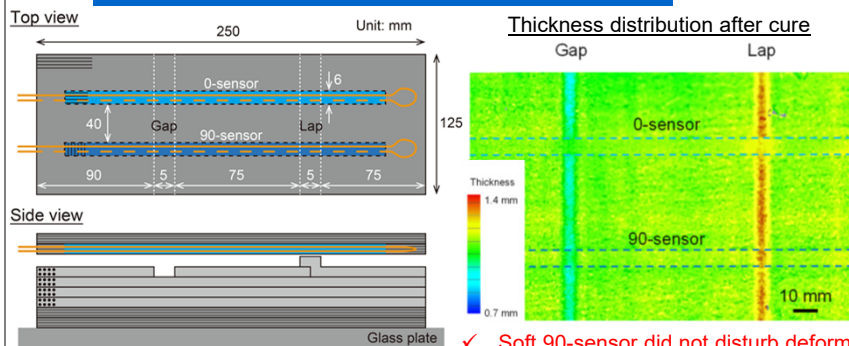


## 4. Concept for consolidation monitoring

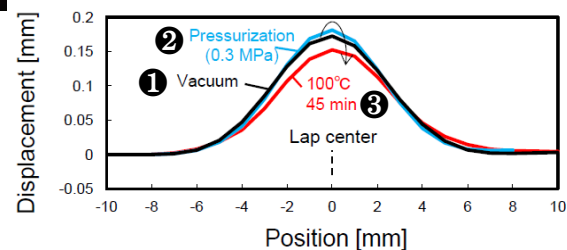
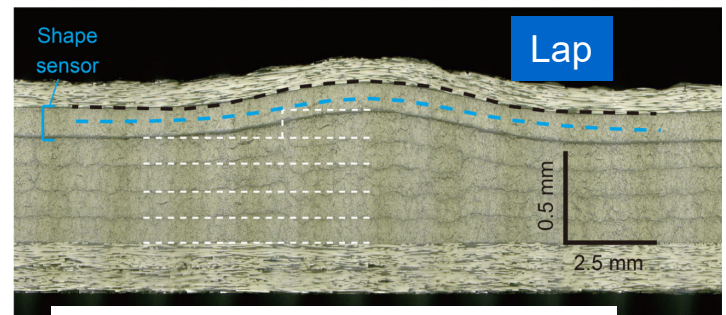
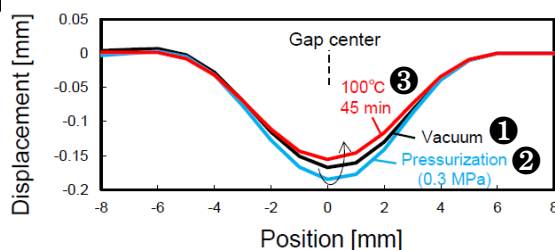
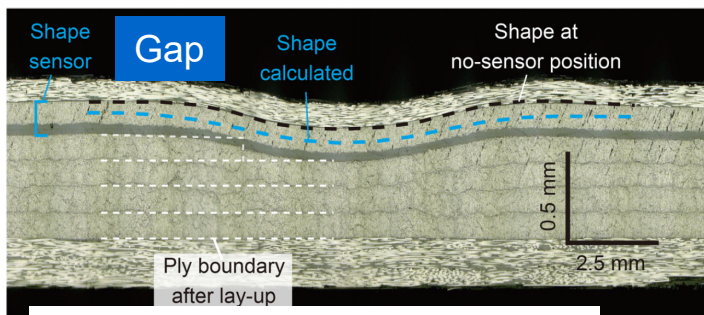


- ✓ Embedded flexible sensor deforms with surrounding plies
- ✓ Shape can be back-calculated from bending strain measured

## 5. Composite gap/lap monitoring



✓ Soft 90-sensor did not disturb deform.



- ✓ Shape calculated from sensor agreed well with cross-sectional observation
- ✓ Deformation deepened once and then became shallower as resin/fiber flowed