

## [Computational Solid Mechanics for Hydrogen Society]

Center for Research on Innovative Simulation Software

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Multi-scale solid mechanics

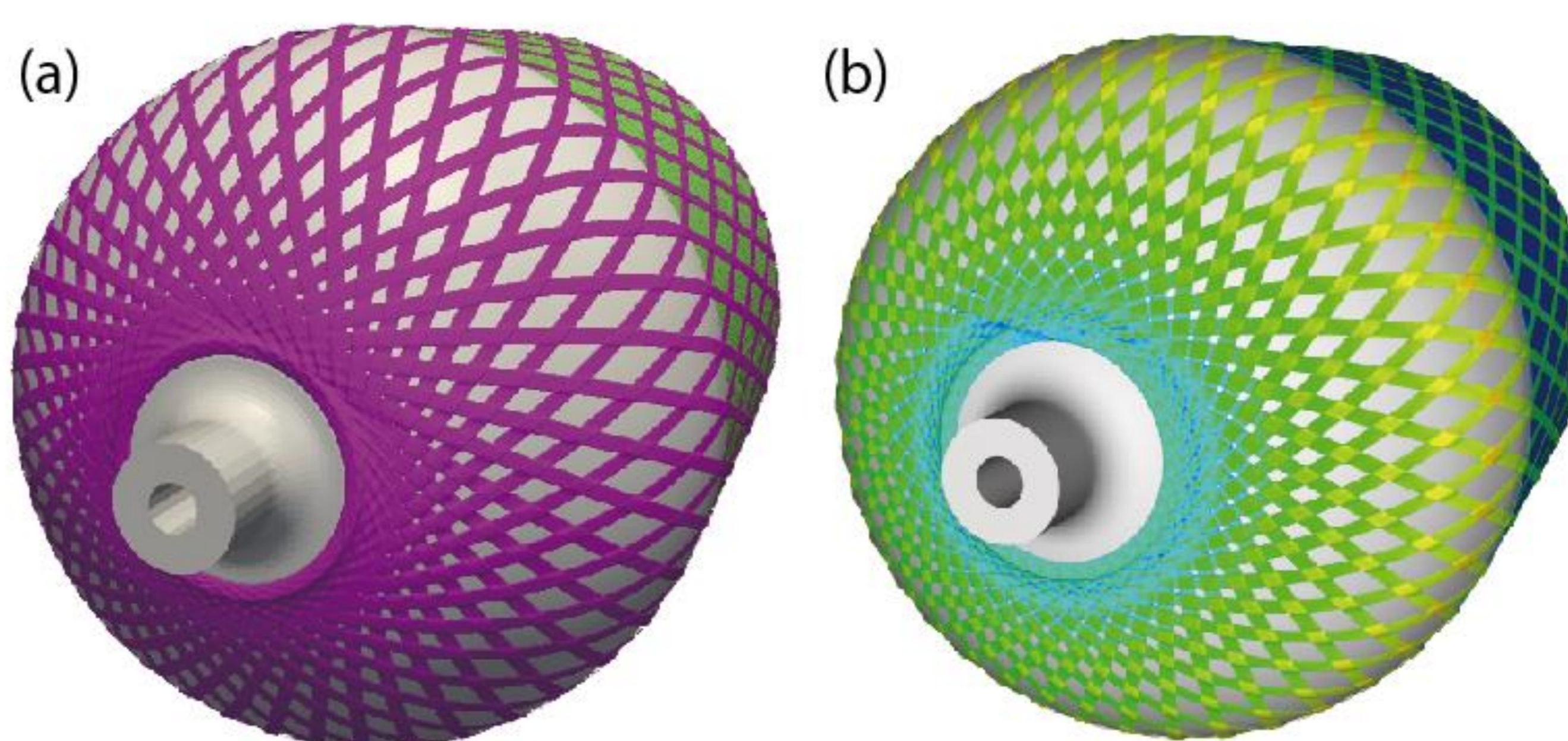
Graduate school of engineering, Department of Mechanical Engineering

## Simulation-aided Design and Production of High Pressure CFRP Tank for Hydrogen Storage

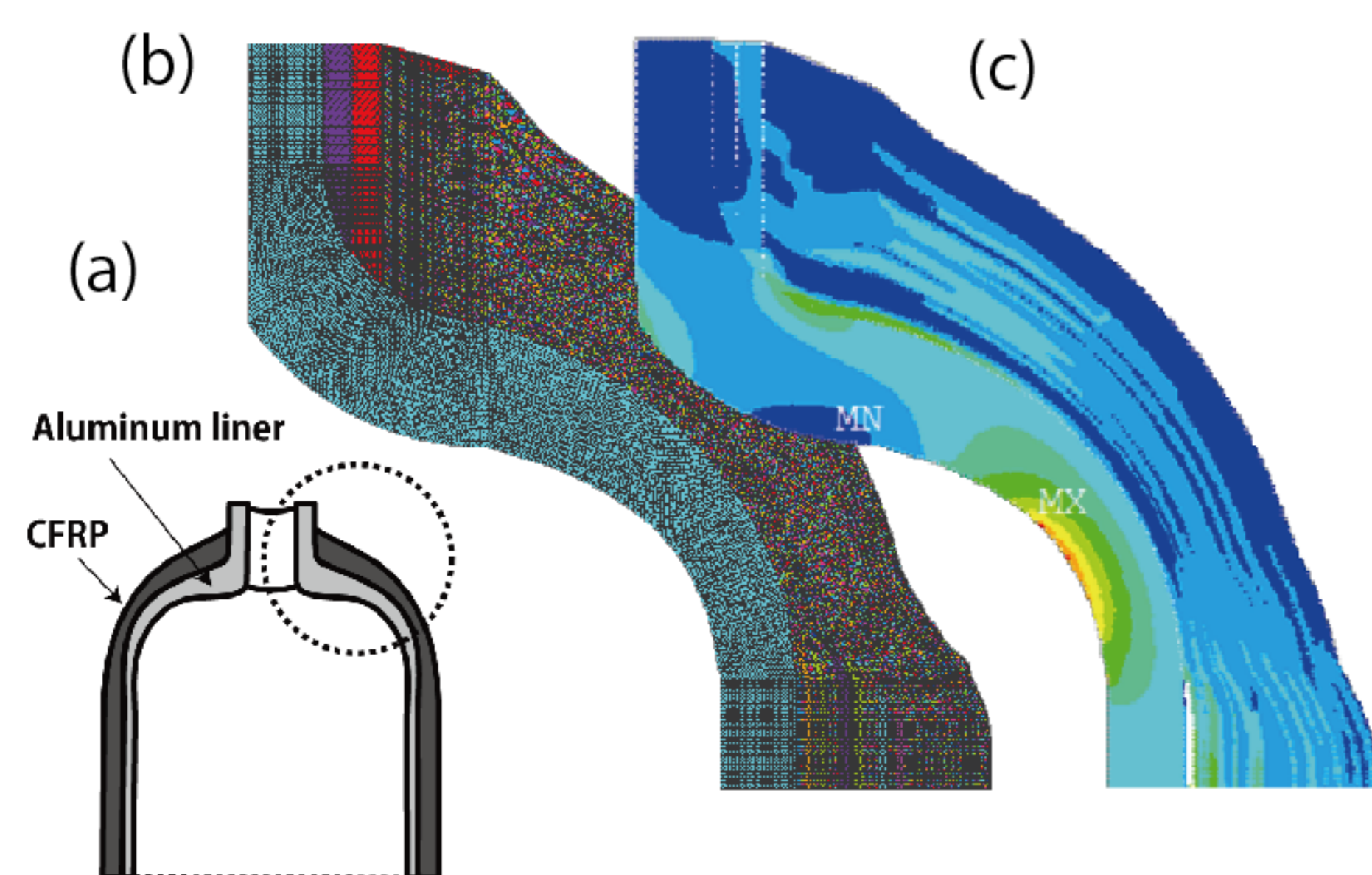
## Optimization of meso-scale design parameters

(a) Meso-scale FEM model of aluminum liner, fiber, and plastic resin, (b) First principal stress distribution.

The aim is to optimize winding paths and size of fiber bundles by evaluating local stress concentration caused by crossover of fiber bundles with the supercomputer KEI.



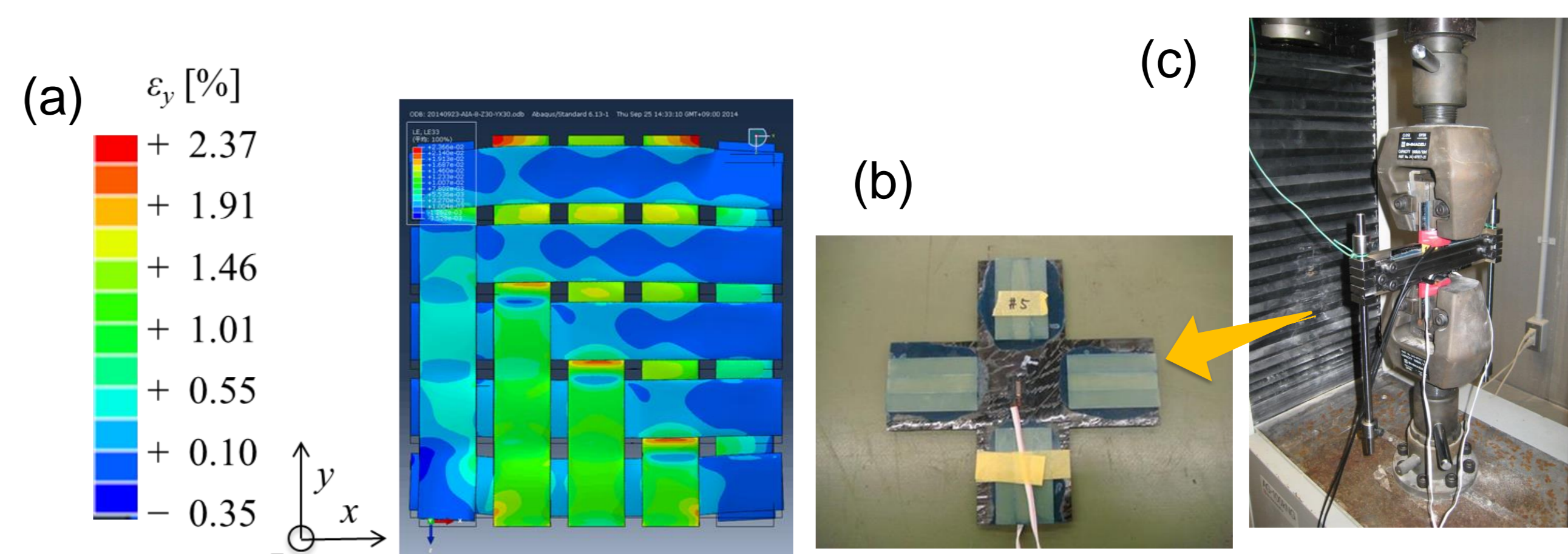
## Strength analysis of Type 3 accumulator dome part



(a) Intersection of tank: Aluminum liner and CFRP composites, (b) FEM model for anisotropic CFRP laminates, (c) Mises stress distribution.

This simulation precisely models laminate structure of anisotropic CFRP material for adequate stress evaluation of aluminum liner.

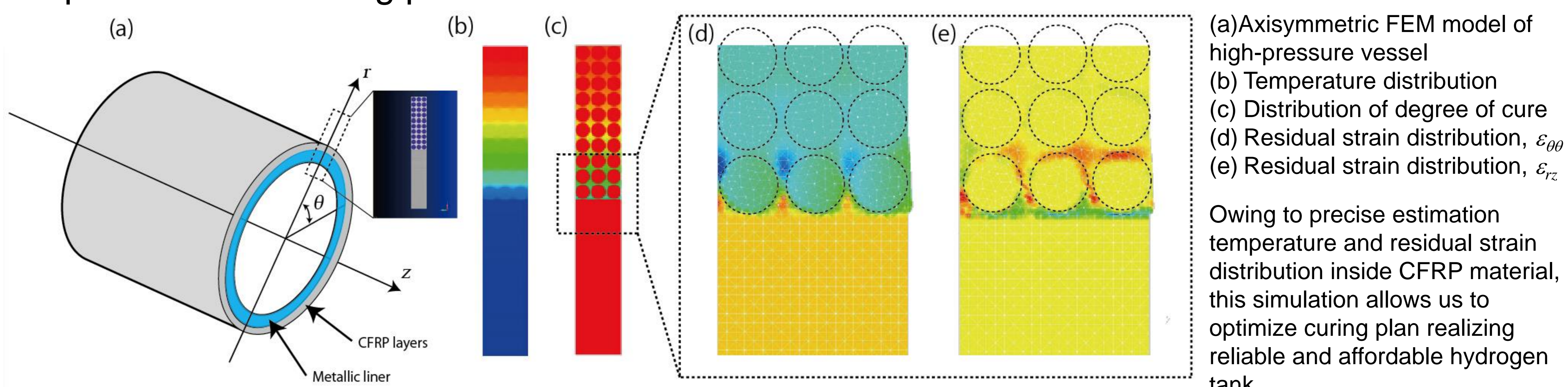
## Validation of meso-scale simulation with tensile test



(a) Distribution of strain in carbon fiber bundle, (b) Biaxial test piece, (c) Biaxial tensile test setup.

Meso-scale FEM analysis can precisely predict fiber bundle break by evaluating strain concentration in fiber bundle crossover.

## Optimization of curing process

(a) Axisymmetric FEM model of high-pressure vessel  
(b) Temperature distribution  
(c) Distribution of degree of cure  
(d) Residual strain distribution,  $\varepsilon_{\theta\theta}$   
(e) Residual strain distribution,  $\varepsilon_{rz}$ 

Owing to precise estimation temperature and residual strain distribution inside CFRP material, this simulation allows us to optimize curing plan realizing reliable and affordable hydrogen tank.