Development of an optical method to measure deformations of nuclear fuel cladding

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Summary

1. Context
2. Speckle interferometry
3. Application
4. Conclusion
1. Context

- PWR (ceramics UO2 or MOX)
- Normal condition
1. Context

- Transient power

Only Material Test Reactor (MTR)
1. Context

- CEA new device
  - Induction oven
    - Same thermal conditions as in reactor
    - Create deformation on cladding
  - Subject of the study

To measure in real time the deformation of the external face of the clad
1. Context

- **Specification**
  - Real time measurement
  - High temperature of the cladding
  - Electromagnetic fields
  - Hotlab chamber: lack of space
  - Deformation: magnitude from few to hundreds \( \mu m \), circumferential

- **State of the art: Optical methods**

  Measurement of the cladding deformation by Speckle interferometry
2. Speckle interferometry

- Optical interferometry

Comparison between two states: measure of displacement
2. Speckle interferometry

- Speckle Pattern

⇒ Cladding = rough surface
2. Speckle interferometry

- Speckle interferometry

Fringes: access to the deformation

➡️ Fringes are lines of level
3. Application

- **Experimental device**
  - Source
  - Lens
  - CCD camera
  - Beam splitter cube
  - Reflective surface under test
  - Reference surface
3. Application

- Deformable cylinder

- Metallic cylinder

- Cone

- Retaining
3. Application

• **Results**
  - Same constraint
  - Range: 0° to 180°
  - One measure each 10°
3. Application

- **Is it a deformation?**
  - Modeling deformation on a tube

  - Triangular
  - Gaussian
  - Bulge
3. Application
3. Application

- Comparison

Not a circumferential deformation!

At least 2 contact points
4. Conclusion

• Speckle interferometry works
  – Feasibility test are finished
  – Good resolution for our application
  – Problems: thermal condition, vibration

• Perspectives
  – Absolute value of displacement
    ➔ Phase shifting analysis
  – Hotlab cells constraints
Thanks for your attention