

# Progress of ITER Feeder System Electrical Insulation Qualification

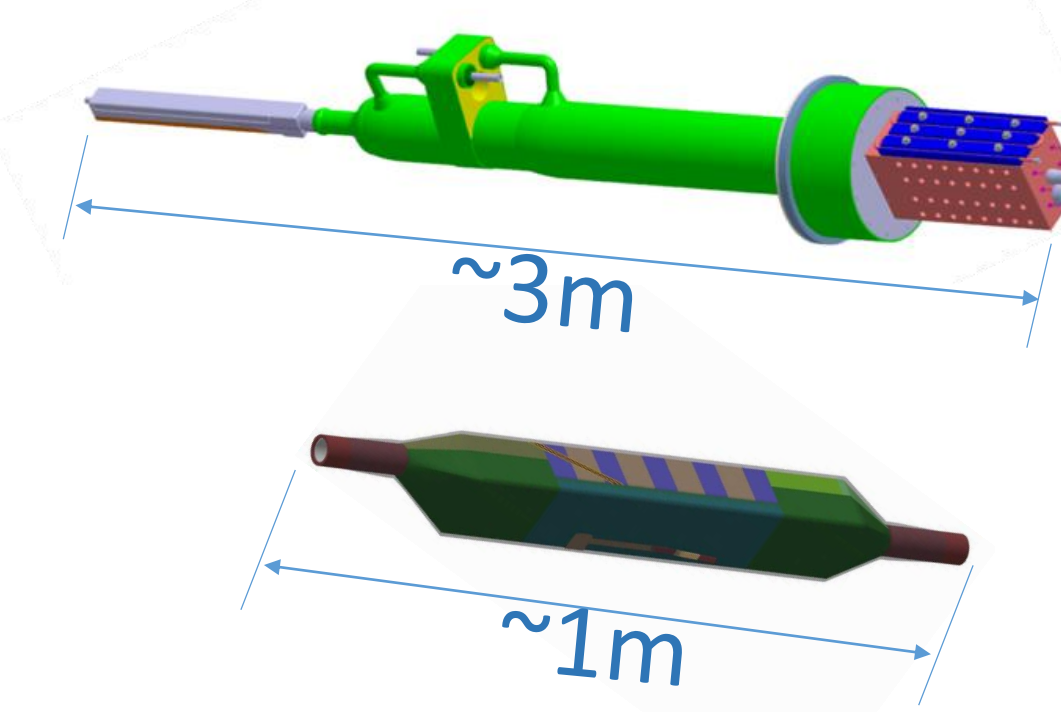
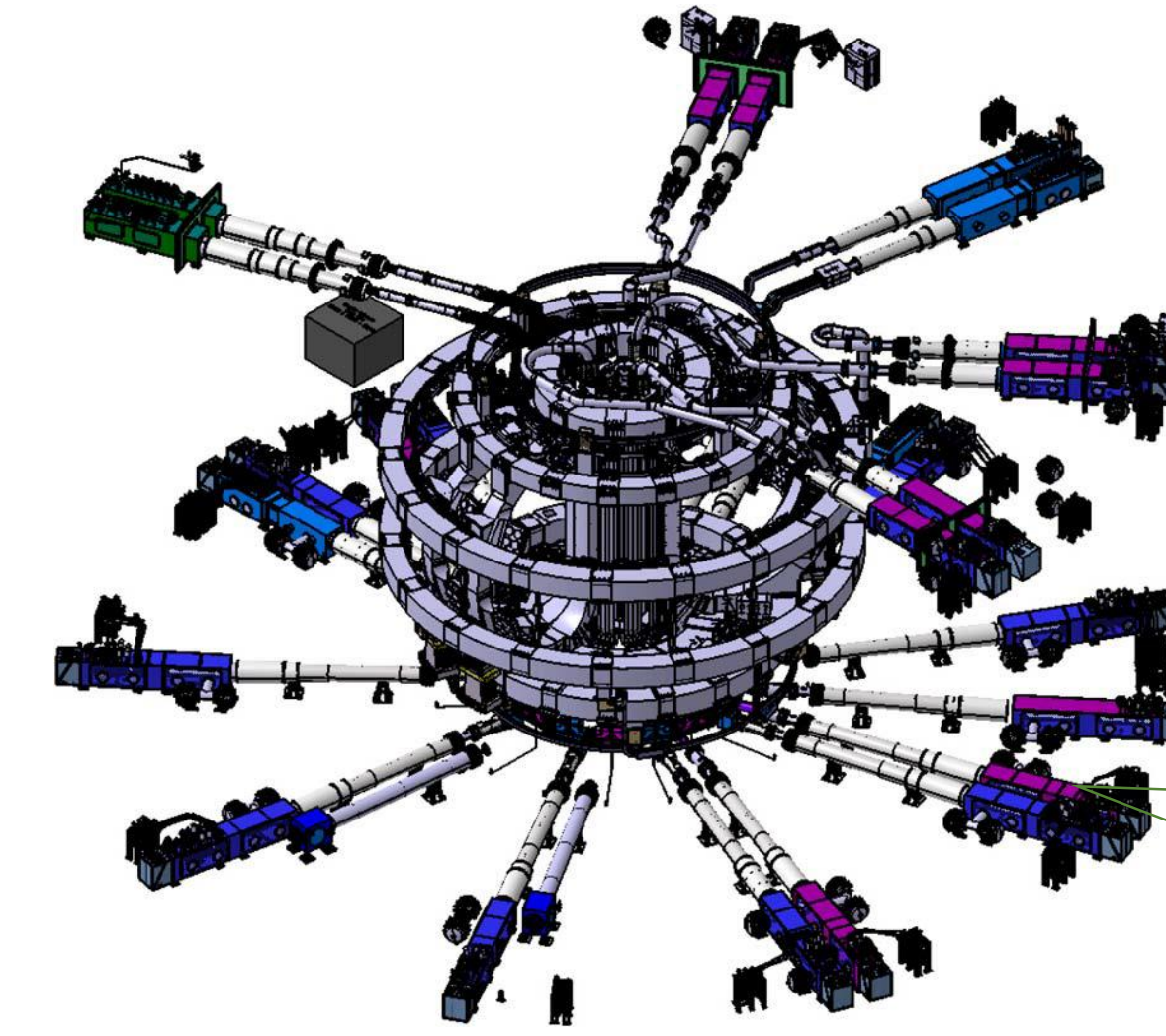
X. Y. Huang<sup>1</sup>, N. Clayton<sup>2</sup>, K. Lu<sup>1</sup>, G. L. Li<sup>1</sup>, C. Wang<sup>1</sup>, Z. H. Dai<sup>1</sup>, C. Y. Wang<sup>1</sup>, L. L. Fang<sup>1</sup>, C. Liu<sup>1</sup>, C. Y. Gung<sup>2</sup>, A. Devred<sup>2</sup>, Y. T. Song<sup>1</sup>, E. W. Niu<sup>3</sup>

1. Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP), China, 2. ITER Organization, France, 3. China International Nuclear Fusion Energy Program Execution



## Background

- ITER Feeder system is an important sub-system of ITER Tokamak, it transmits the electrical power from the power suppliers to the coil terminals.
- In order to prevent the accidents of the arcing across the parts in the feeder, the HV components need to be insulated with one layer of pre-impregnation glass fiber and polyimide composite.
- The static tensile/shear strength, the fatigue tensile strength, the compression-shear strength, the push-out strength and the void content shall pass the qualification based on PA acceptance criteria.



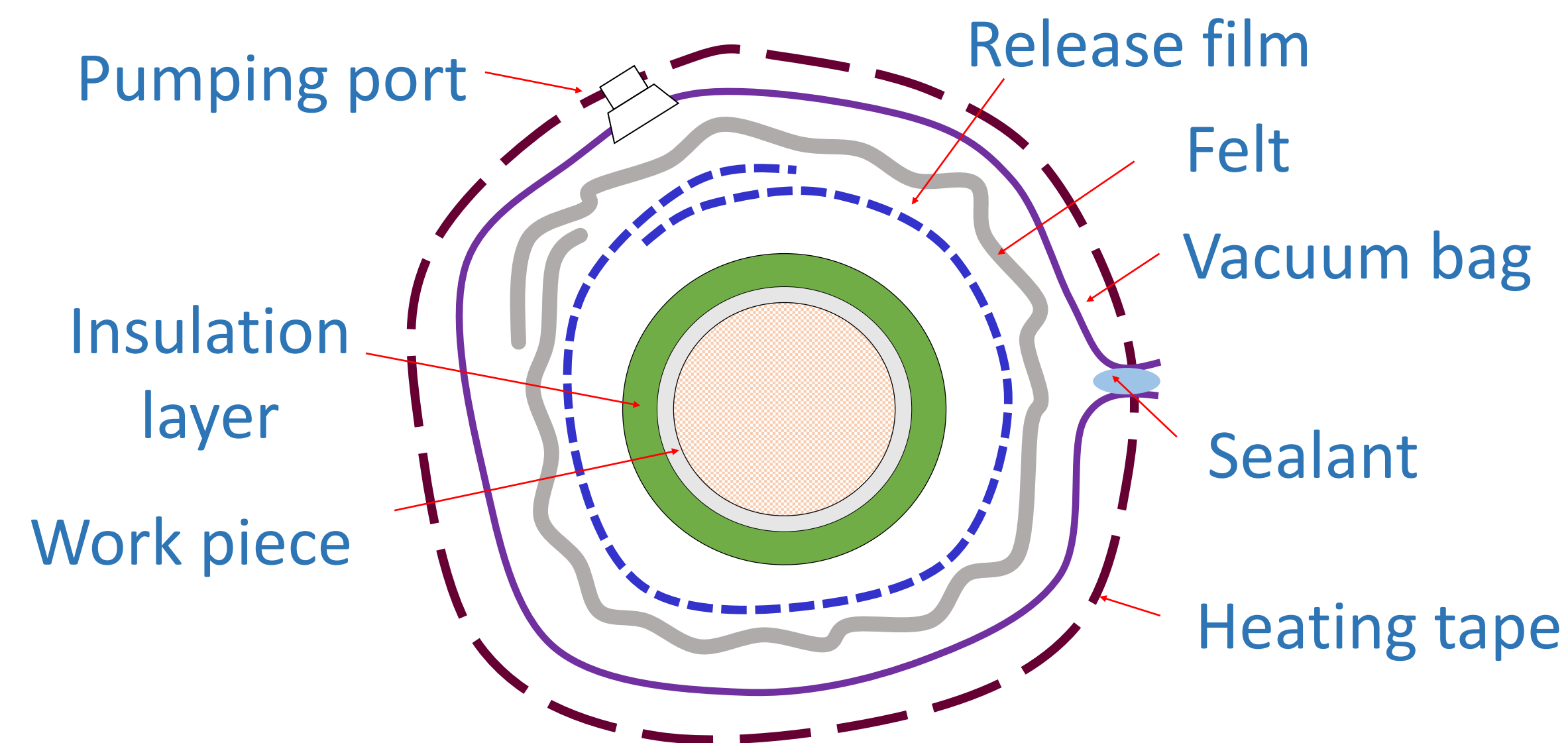
26 feeders supply the large current to the coils.

## Criteria @77K

	Initial status	After fatigue
UTS(0 degree)	500MPa	200MPa
UTS(90 degree)	200MPa	100MPa
ILSS	50MPa	-
Compression-shear	60MPa	-
Push out	25MPa	-
Void content	<2%	-

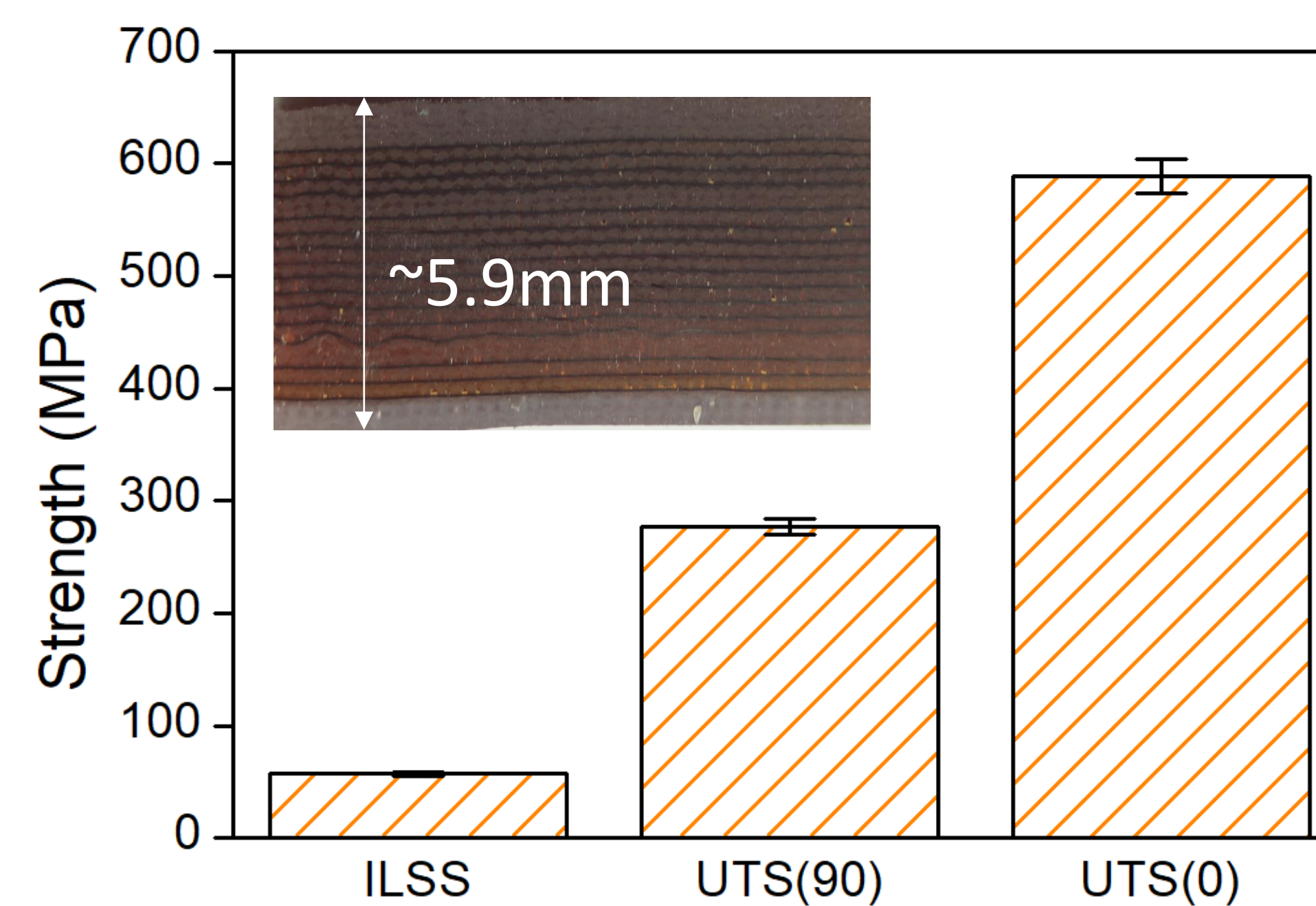
## Materials and Technology

- Main materials:** Pre-preg (Gurit SE84LV), Glass fiber (Sinoma RW210a), Polyimide (Dupont Kapont-HN).
- Insulation structure:** 9 interleaved layers of pre-preg and polyimide tapes.
- Curing baseline:** pumping in vacuum bag and heating by heating tapes.



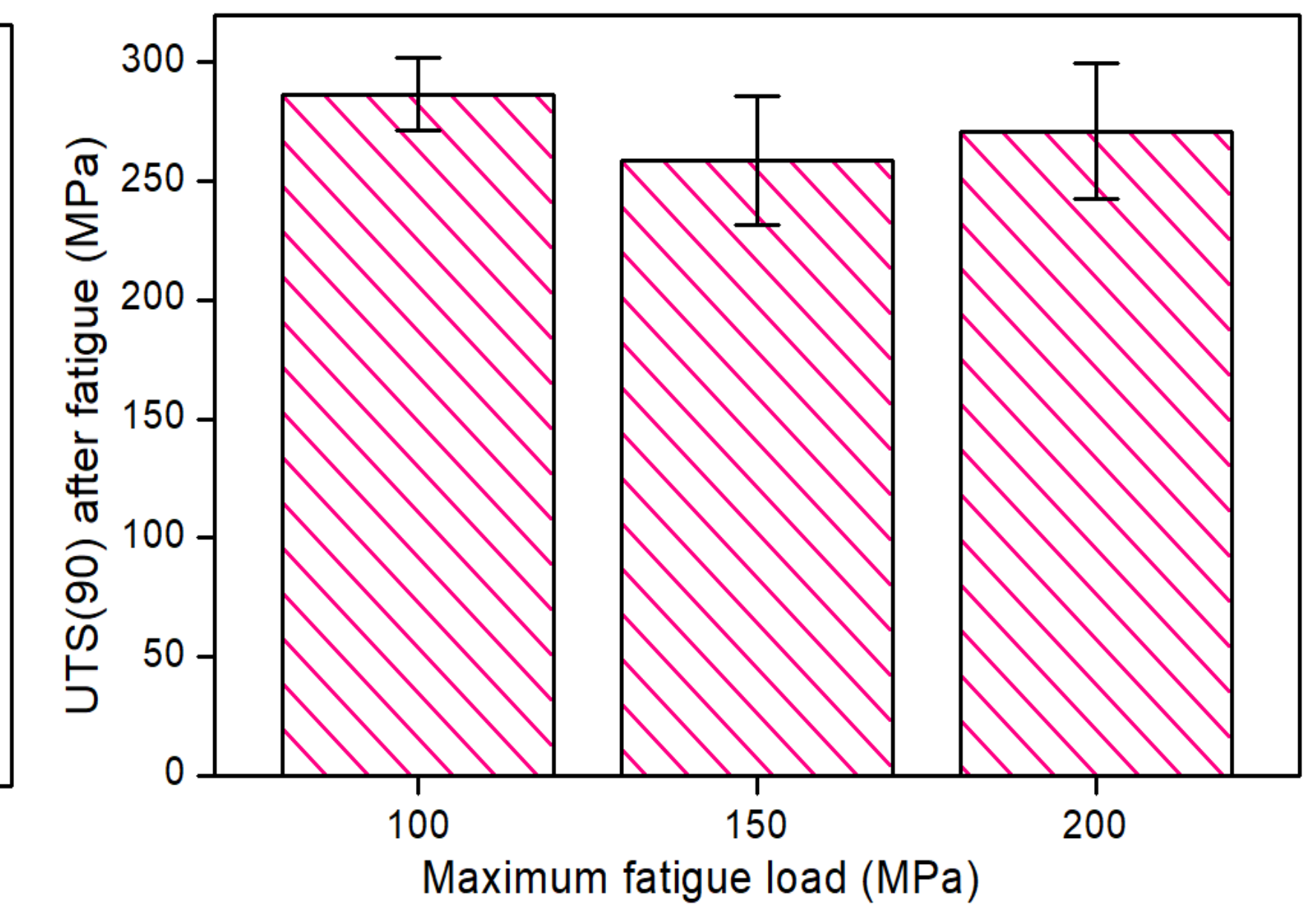
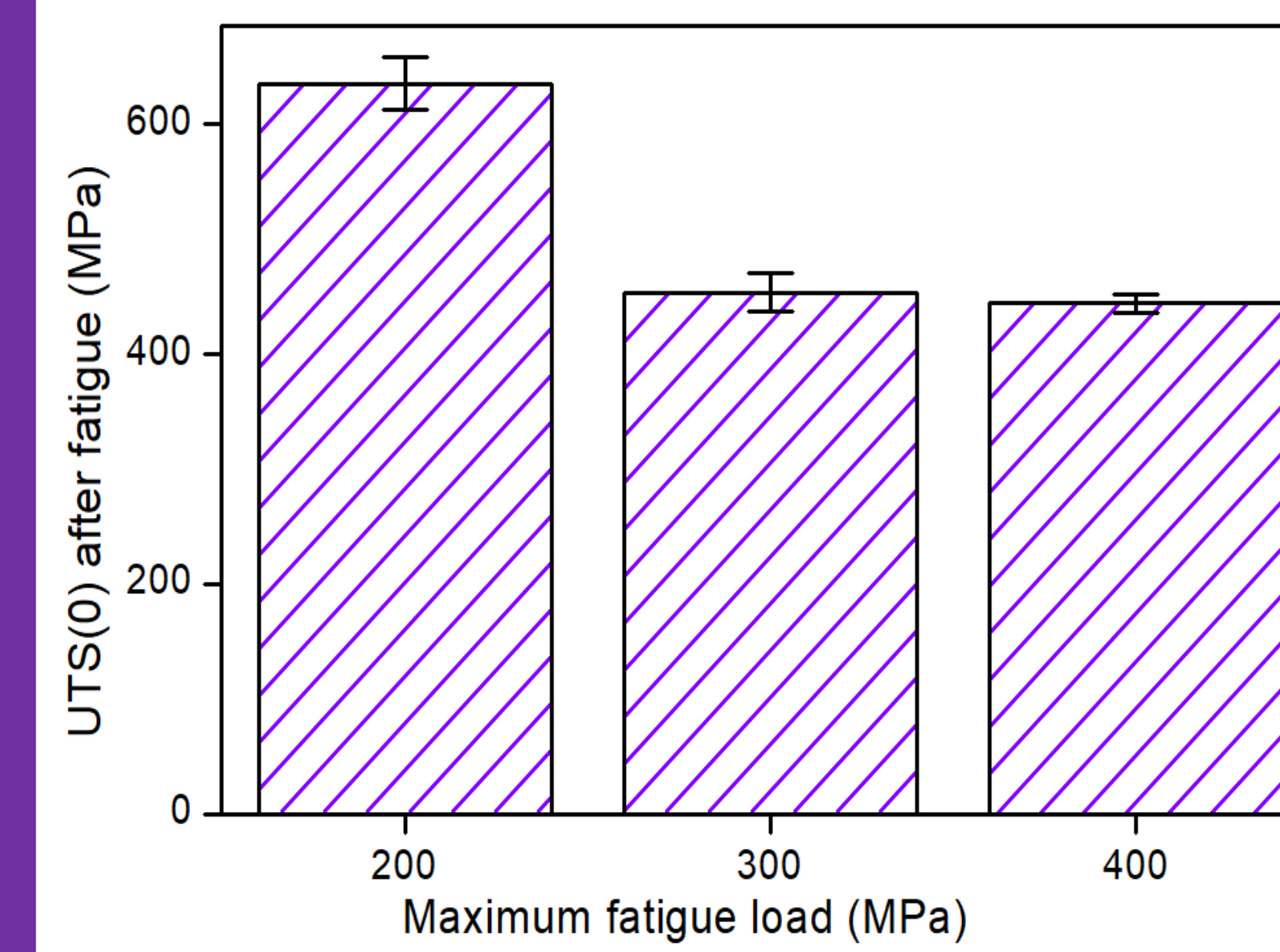
## Static Mechanical and void

- The average ILSS is 57 MPa. The average 90 degree UTS is 277 MPa. The average 0 degree UTS is 589 MPa.
- Using ignition method to test the void content, the value is ~0.3%



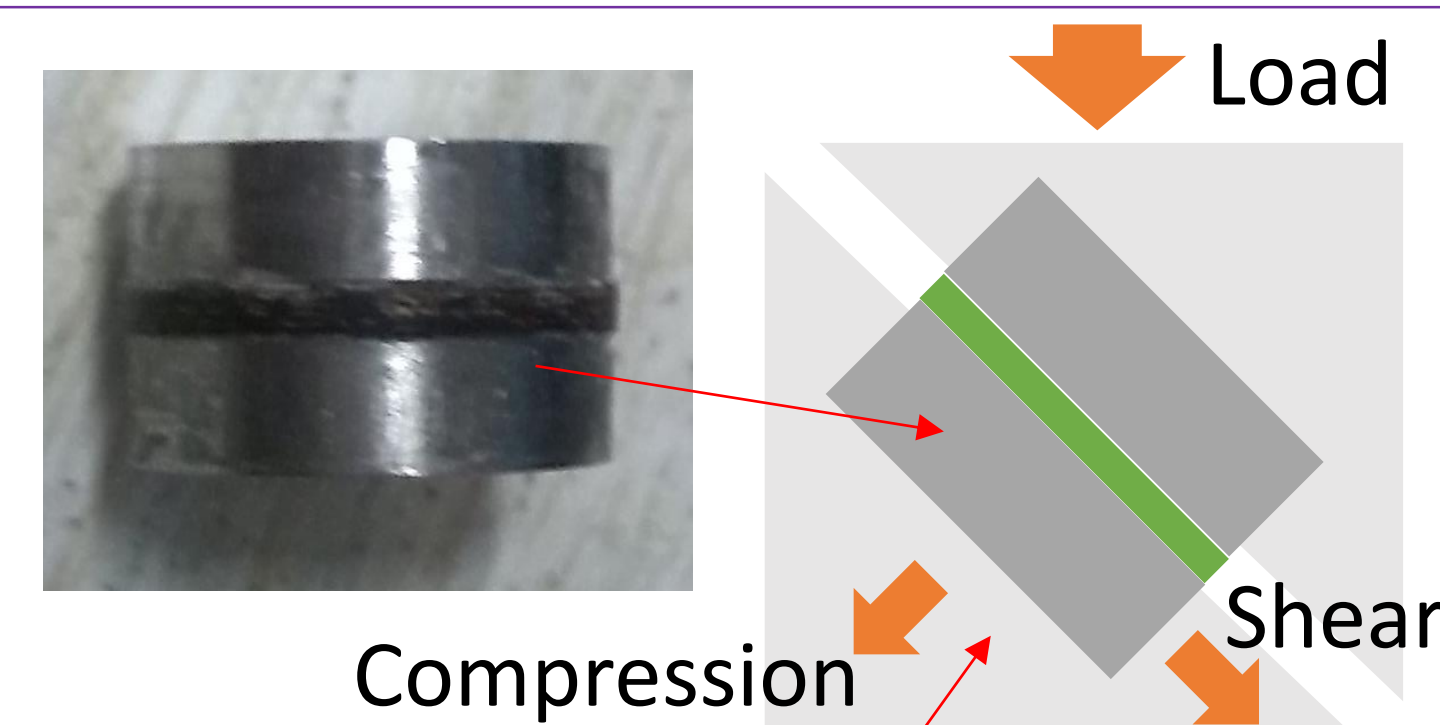
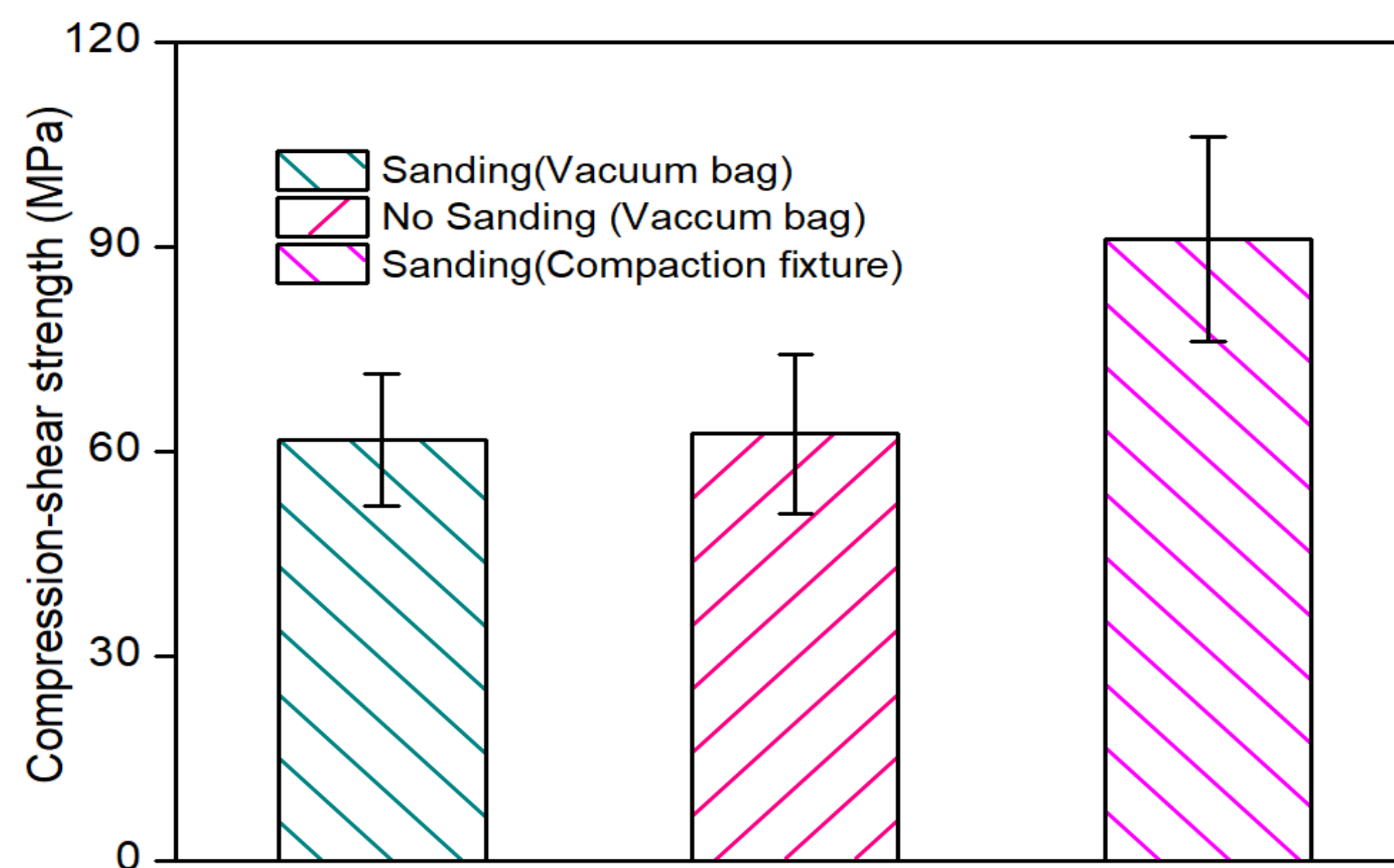
## Fatigue tensile test

- The fatigue cycles was 30000, the frequency was 5Hz. After the mechanical fatigue, the residual tensile strength was tested.
- Minimum fatigue load was equal to 10% maximum load.
- Residual UTS(0) is larger than 440MPa residual UTS(90) is larger than 250MPa.



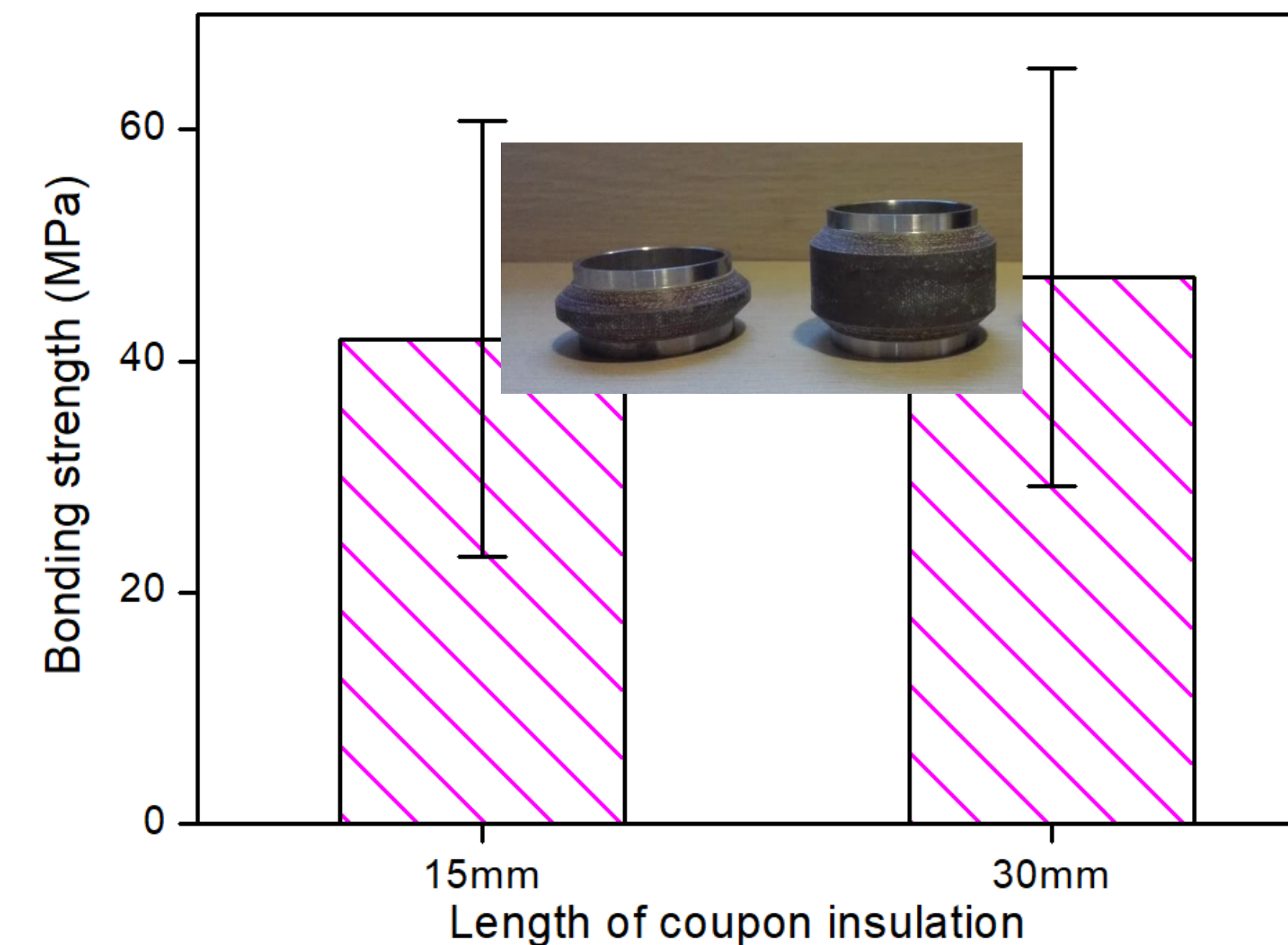
## 45 degree Compression-shear

- “Sandwich” coupon: SS discs + composite
- If curing in vacuum bag, sanding and no-sanding coupon have a similar strength about  $60 \pm 10$ MPa.
- If increase the pressure for curing, the strength increase obviously, up to 90MPa.



## Push out test

- The coupons was cut from a tubular insulation sample.
- The average bonding strength of both 15mm and 30mm coupons can reach to 40MPa.
- Large deviation is caused by the failure position, in normal, the failure in insulation could bring higher strength.



## Conclusion

- The qualification items present in this paper focus on the mechanical properties.
- Based on the material of pre-preg and the vacuum bag curing technology, the UTS, ILSS, compression shear strength, bonding strength and void content can meet the PA criteria.
- ASIPP has launched more qualification on the HV properties of HV component.
- The formal product of ITER Feeder has used the qualified insulation material.

