Mechanical cycling of extremely soft graphene-enhanced thermal interface materials for HPC and AI cooling applications

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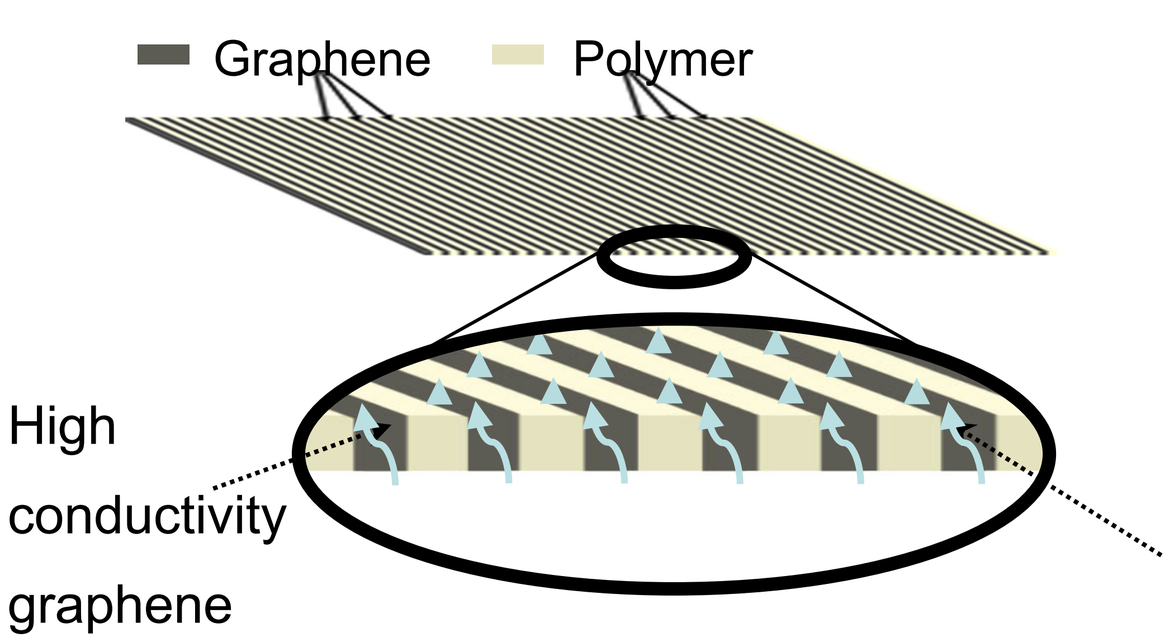
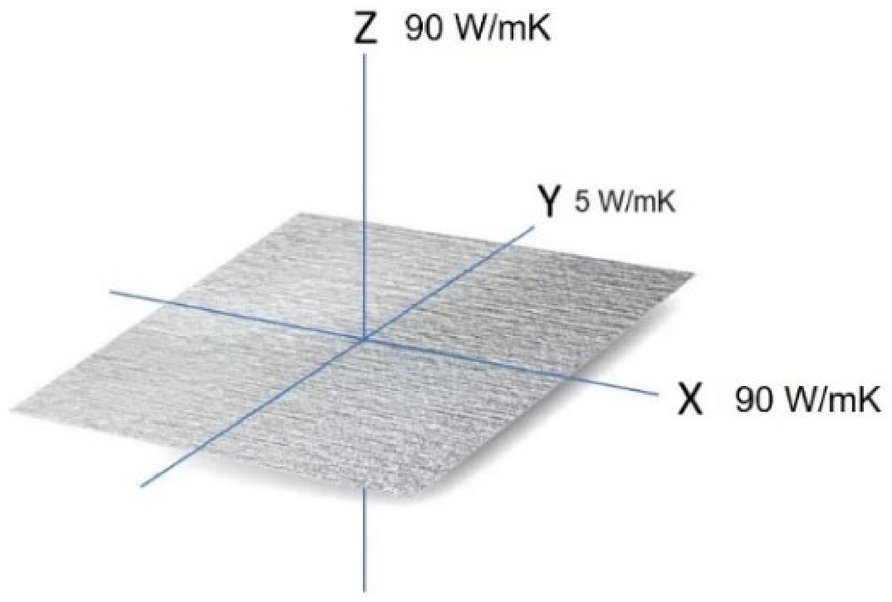
Introduction

Graphene-enhanced thermal interface materials (GT-TIM) are a promising alternative to conventional TIM, but their mechanical resilience under stress and elevated temperature needs further study to validate their long-term use in functional and thermal burn-in tests. We prepared GT-TIMs with various hardness grades in terms of compressive stress and subjected them to up to 5000 compression cycles at 110°C and 552 kPa, followed by thermal impedance and hardness tests to assess their reliability.





Sample properties

The softness properties of the following samples with 0.3mm thick are distinguishable by the compressive stress at 50% compression

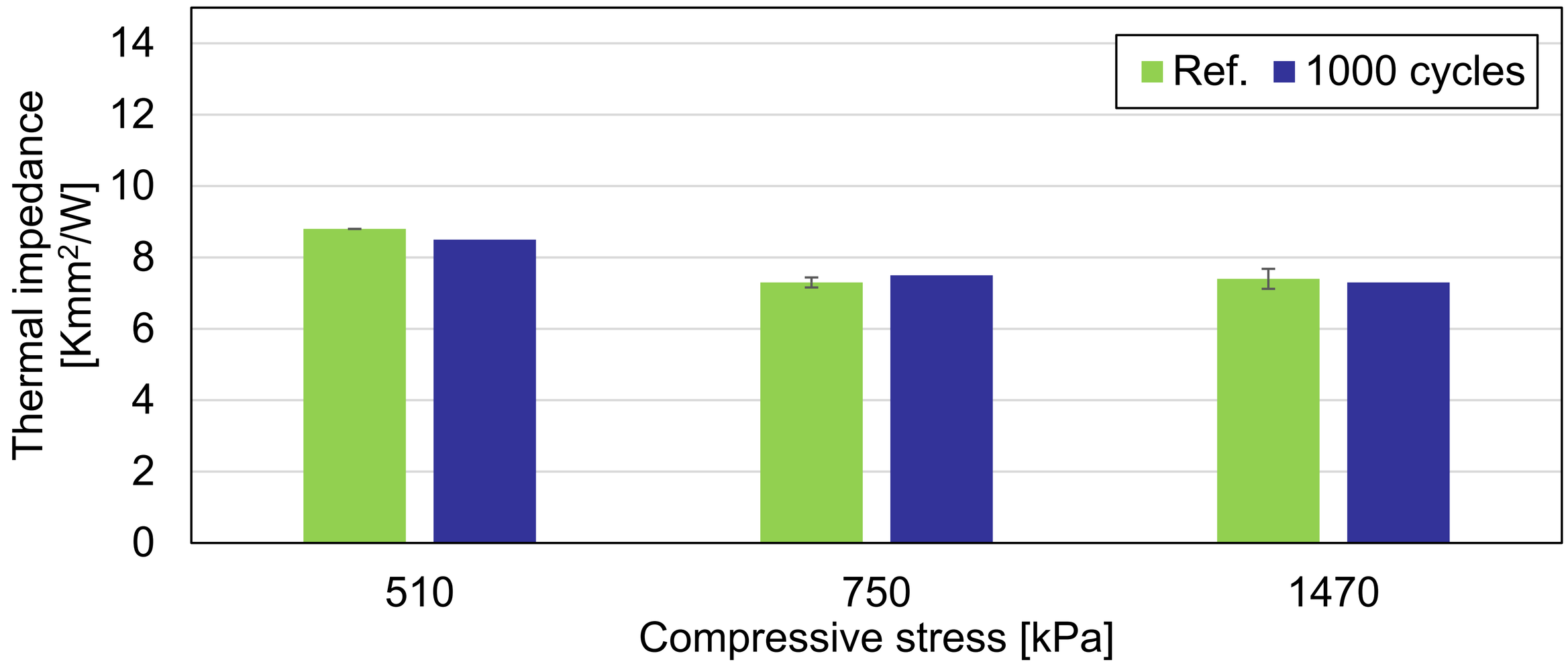
- Sample 1: 510 kPa
- Sample 2: 750 kPa
- Sample 3: 1470 kPa

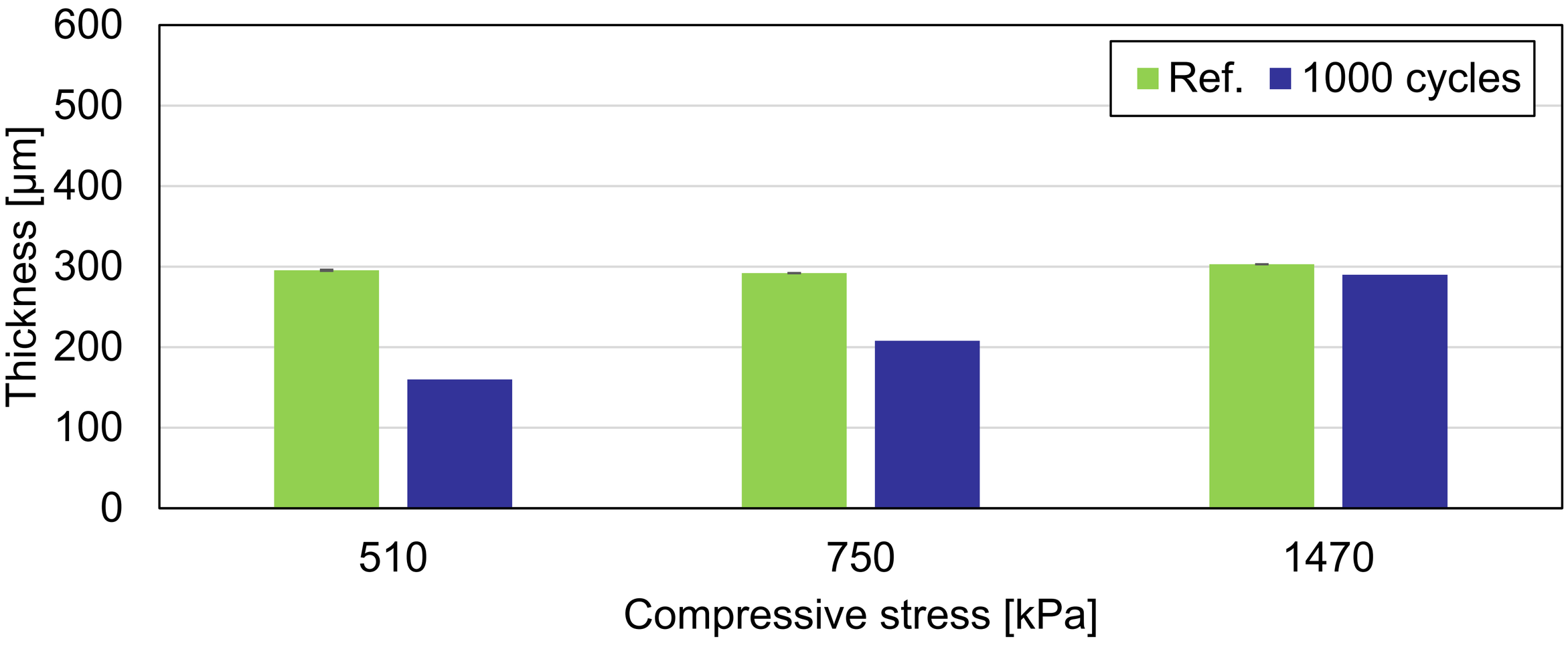
Compression cycle tests

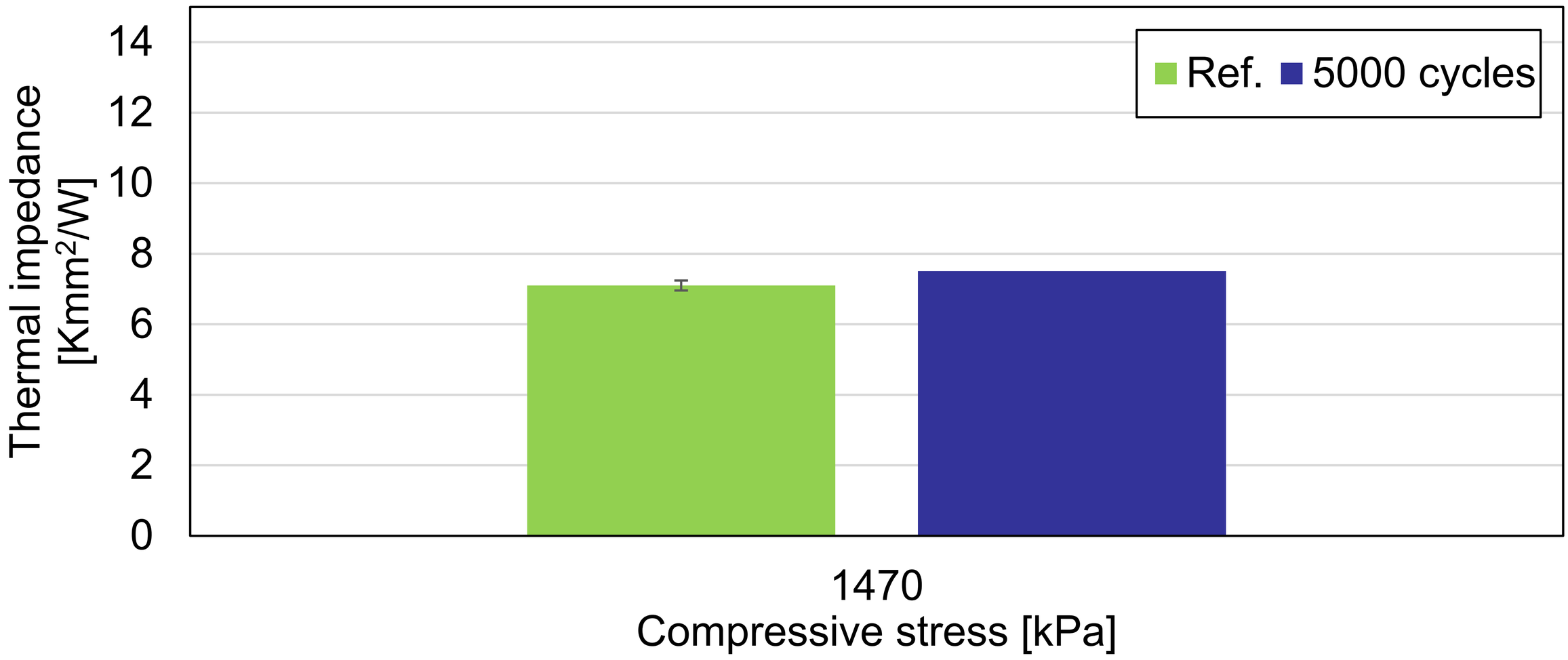
Pads were subjected to cyclical compressive stress under the following conditions, respectively:

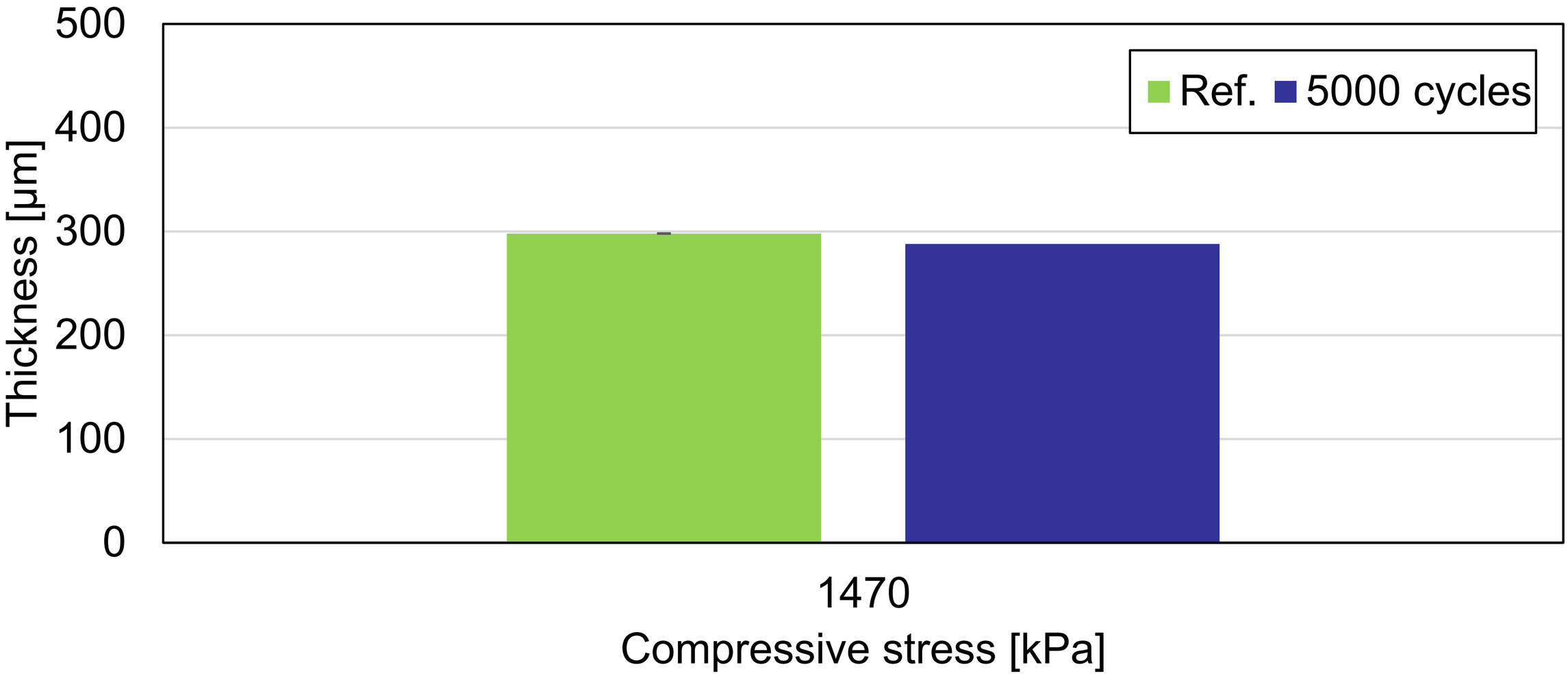
- Method 1: 1000 cycles - 552 kPa (80 psi) - 90°C.
- Method 2: 5000 cycles - 552 kPa (80 psi) - 110°C.

- Thermal impedance was measured with an ASTM D 5470-06 method,
- Compressive stress were determined with an Instron test frame.









Conclusion

1. GT-TIMs can survive method 1 without deteriorating thermal conductivity.
2. Some reduction in thickness was observed for the softer samples.
3. The hardest GT-TIMs survived method 2 without deterioration.

- This work demonstrates that the structural integrity of GT-TIM and its resistance to cyclical compression can be designed based on the hardness of the pads.
- Promising applications would be within HPC, AI, thermal burn-in, and functional testing.

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