

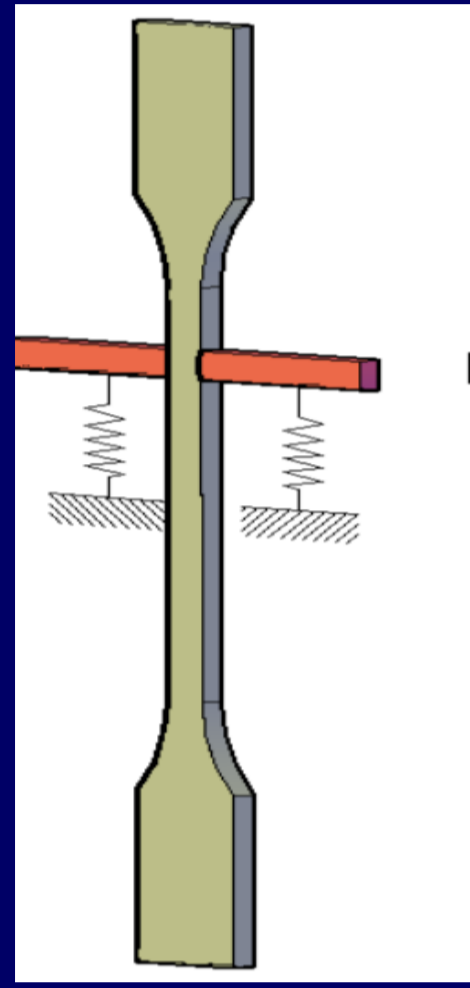
On-line detection of fretting fatigue crack initiation under perpendicular-cylindrical contact by thermography



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Laboratory test



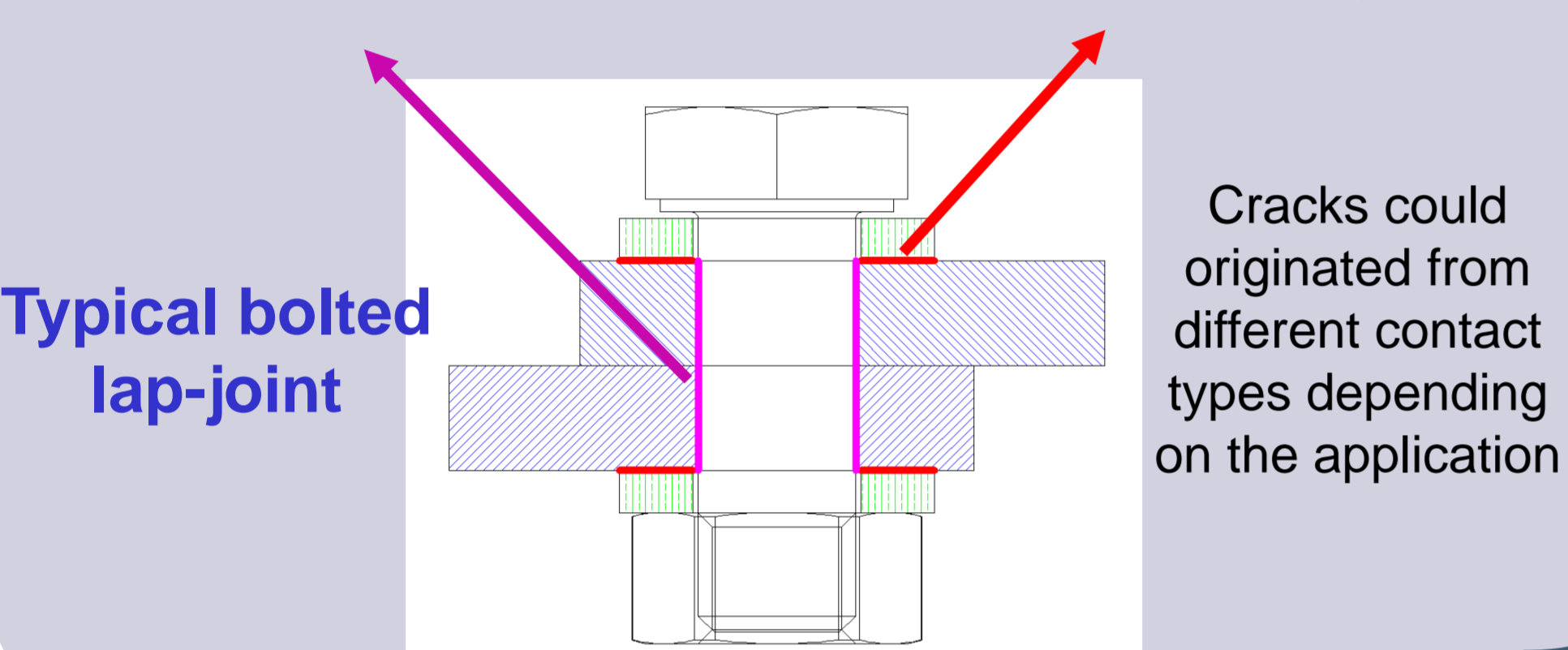
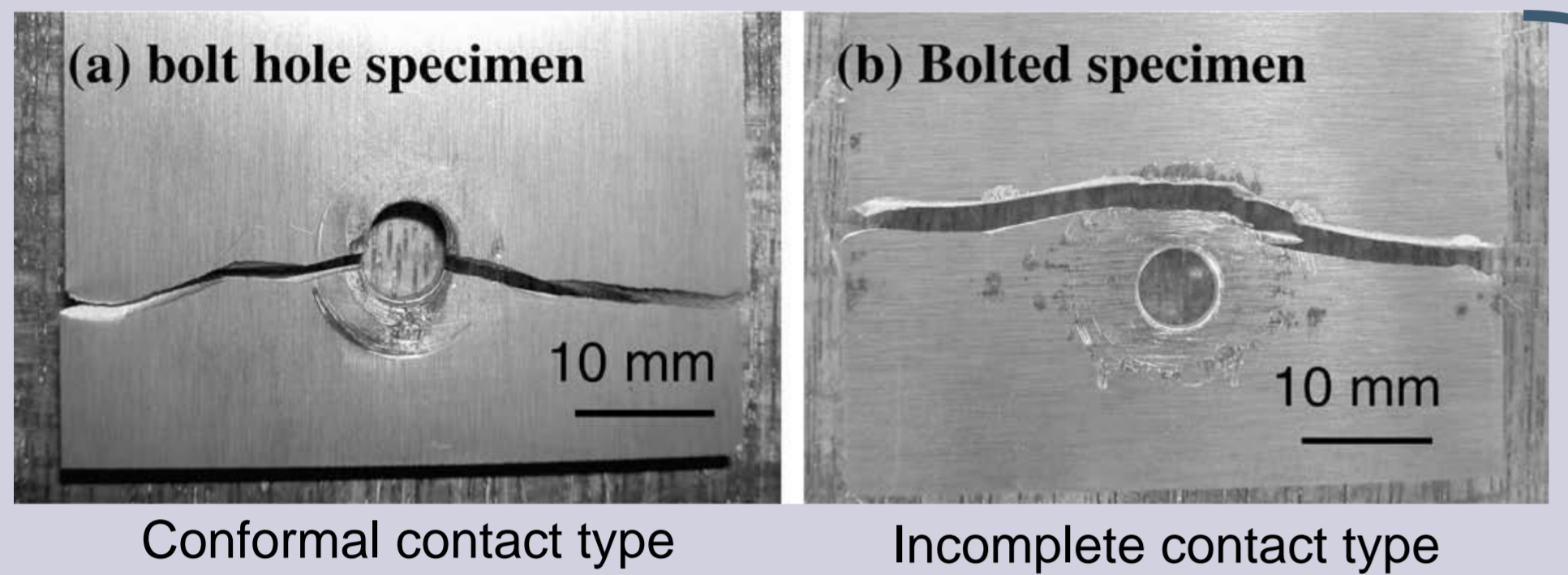
Real engineering problems

Fretting fatigue occurs when two bodies in contact move slightly relative to each other. The amplitude of the reciprocating sliding is in an order of several micrometers. Fretting fatigue may reduce lifetime of materials or components significantly, and it can occur within mechanical joints such as: bolts, rivets, dovetails or press-fits.

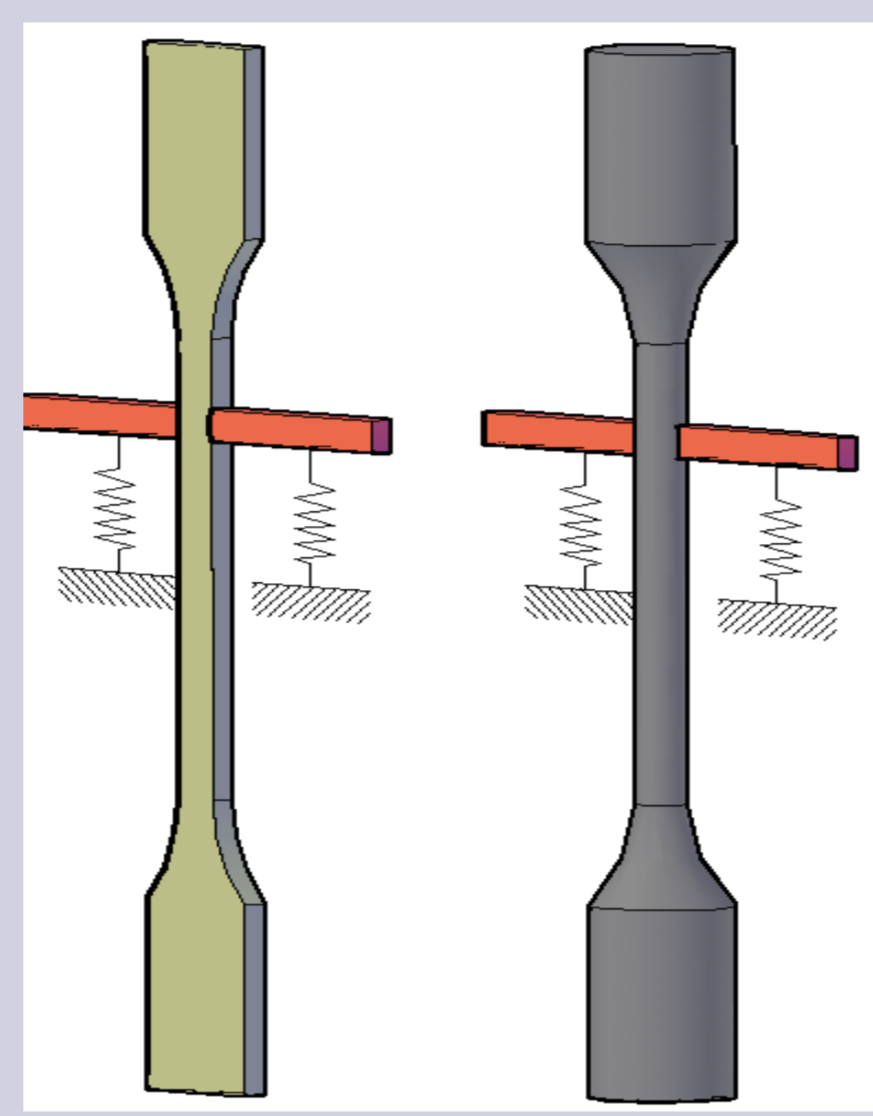
In order to improve understanding of failures of mechanical joints which are widely used in transport vehicles and machineries, a new contact type, perpendicular-cylindrical contact is experimentally evaluated in addition to the conventional cylindrical-plane contact.

Background

S. Wagle, H. Kato (2009)

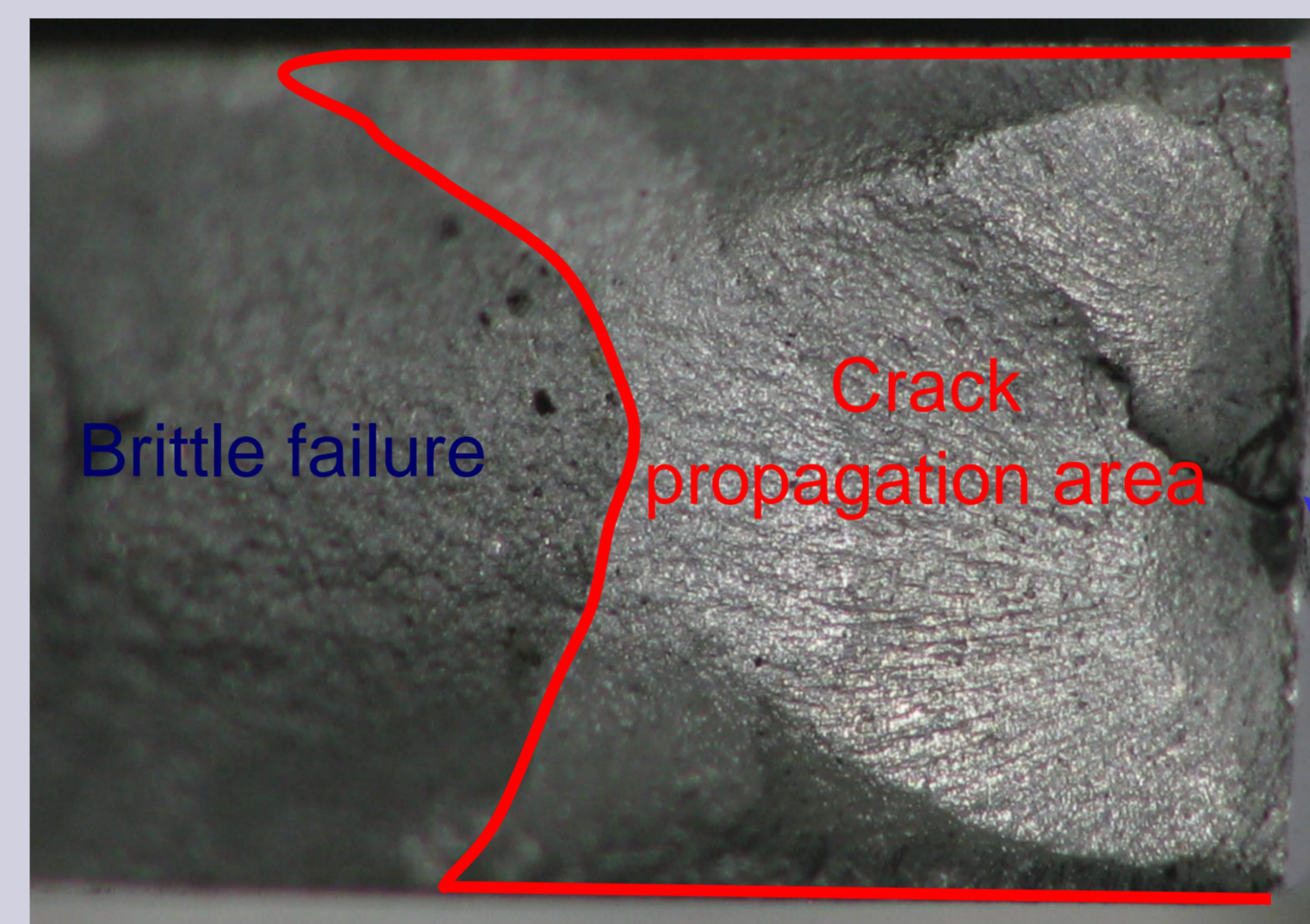


Cracks could originate from different contact types depending on the application

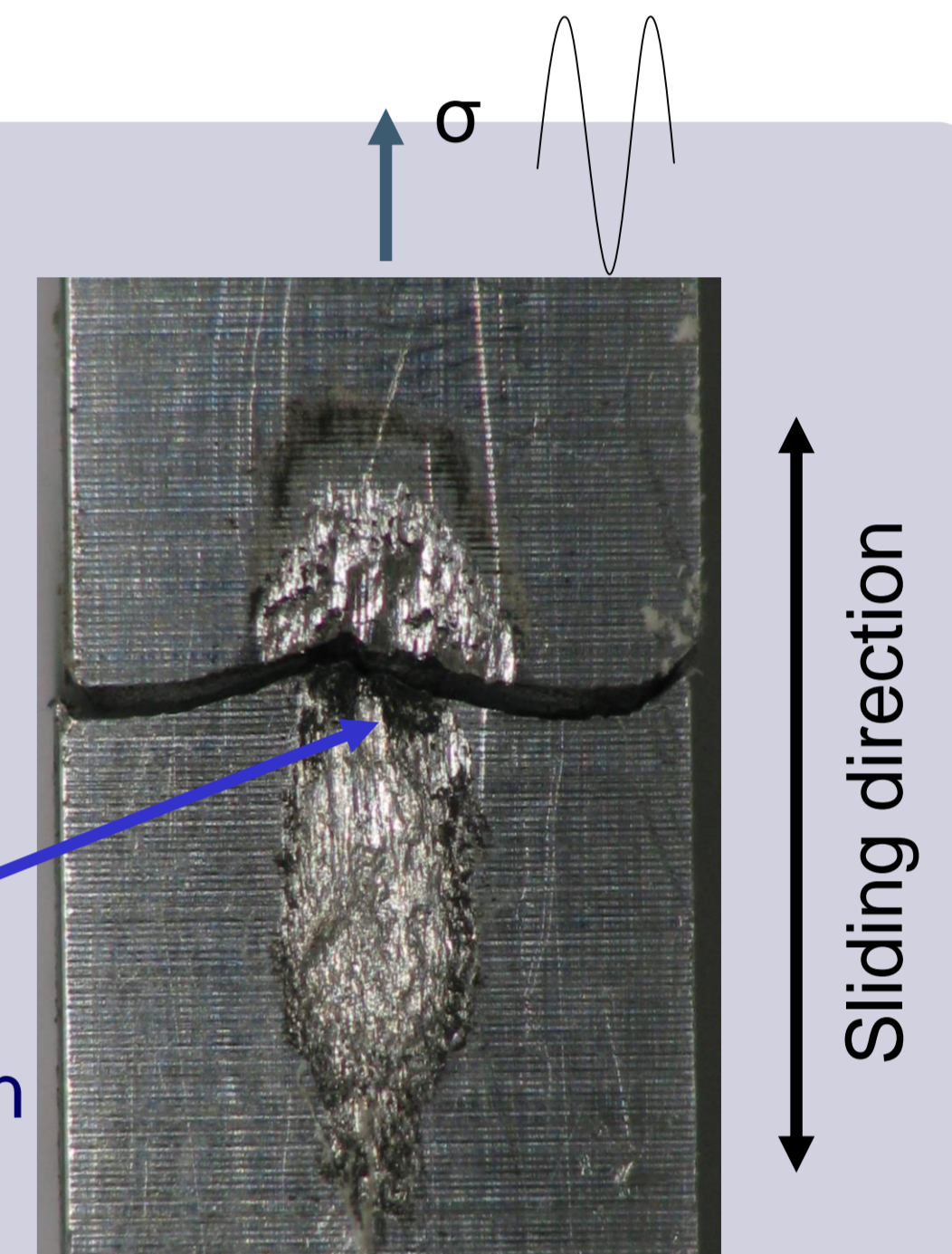


Different contact types in laboratory tests are required

Fractography



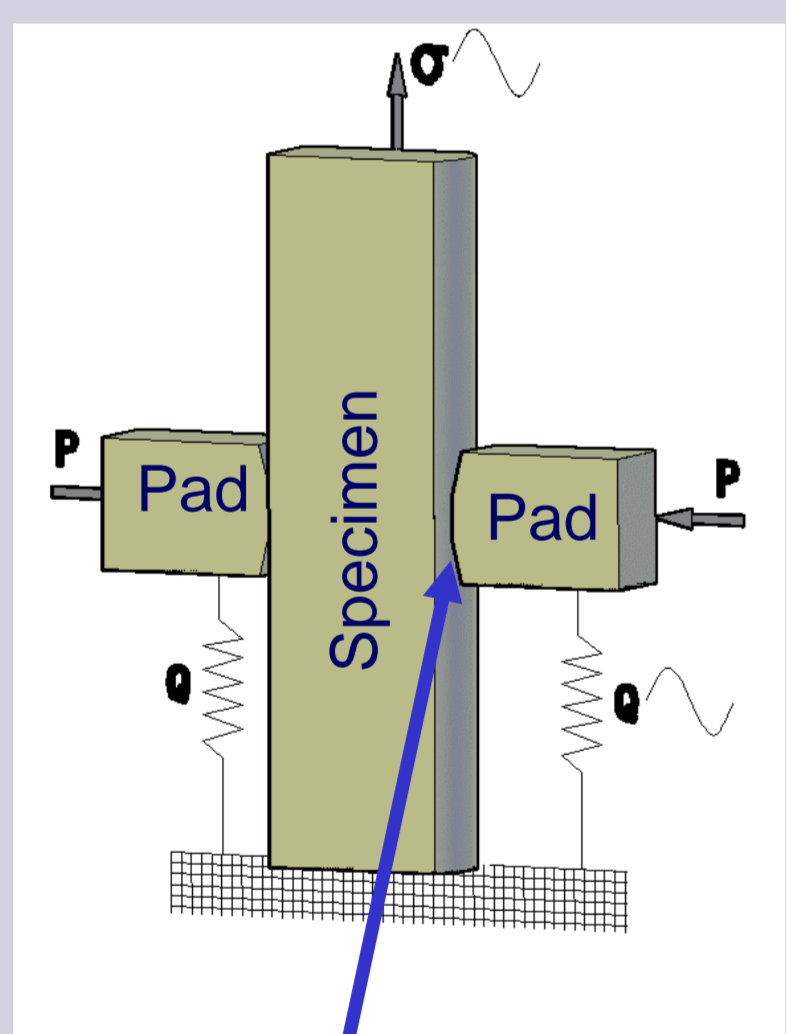
Fractured surface (top view of the failed specimen)



Fretting scar (right view of the specimen)

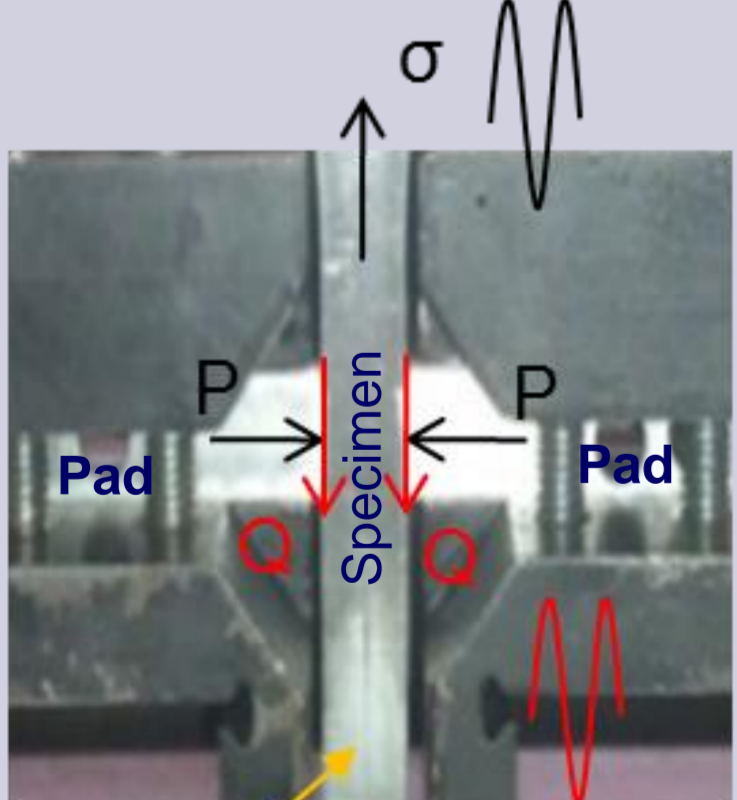
Experiments

Schematic drawing of the fretting fatigue test



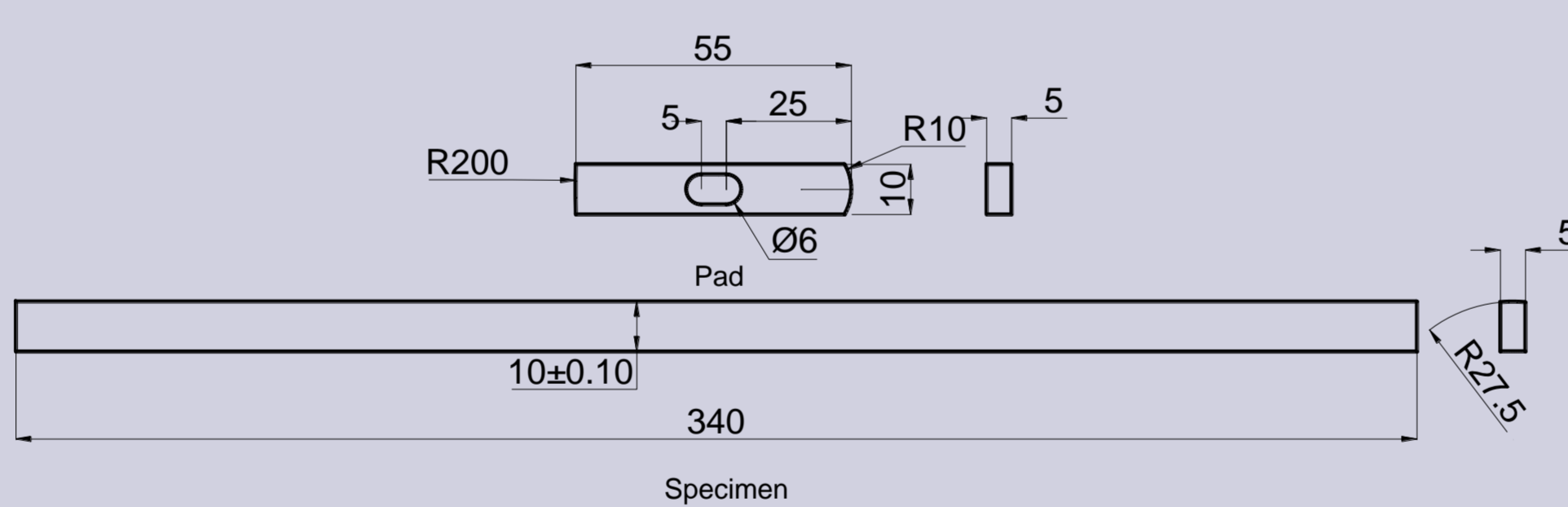
Perpendicular-cylindrical contact

Experimental set-up



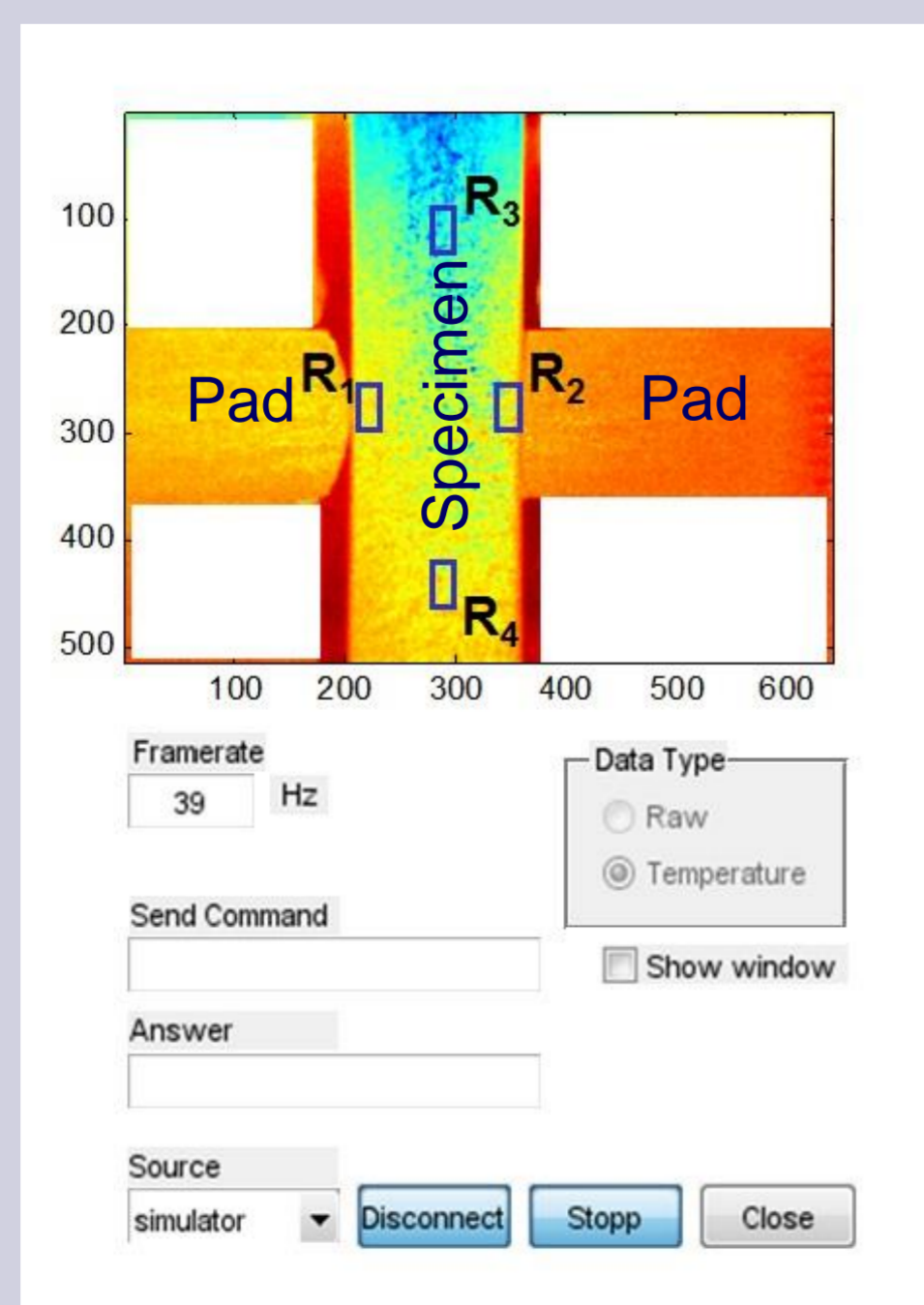
IR Camera

Dimensions and material properties



Materials	Young's Modulus [GPa]	Yield Strength [MPa]	Ultimate Strength [MPa]
Specimen (AL2024-T3511)	73	450	570
Pad (AL2024-T3)	73	383	506

On-line temperature acquisition



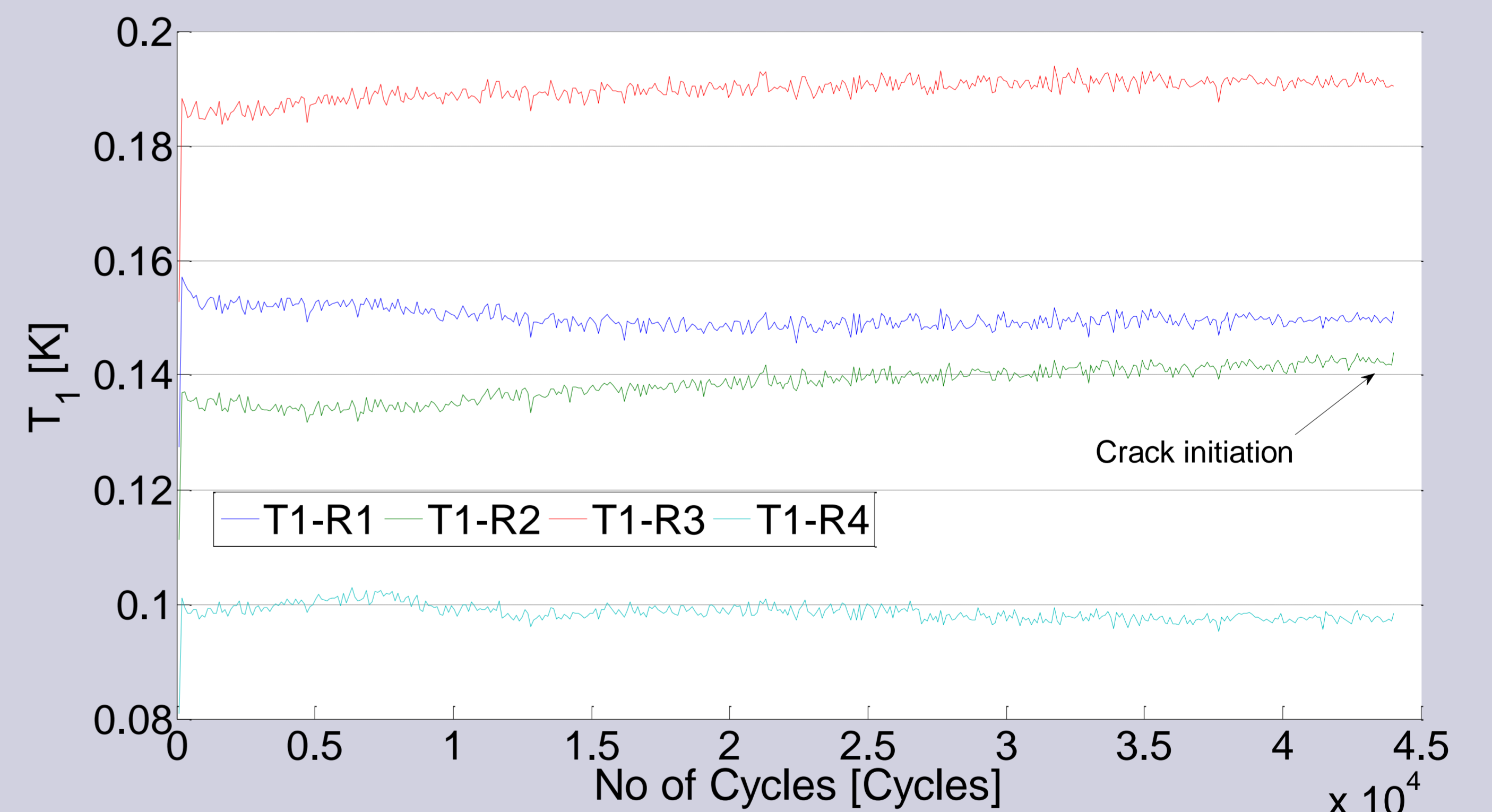
On-line data processing

Thermoelastic temperature amplitude, T_1 , of the four regions of interest is extracted on-line to detect crack initiation!

$$T_1 = -k(\sigma_{kk})$$

σ_{kk} : sum of principal stresses
 k : thermoelastic constant

Results



Optical microscopy for crack at the left contact, R_1 .

Optical microscopy for crack at the right contact, R_2 .

Conclusions

- ❖ Fretting fatigue under perpendicular-cylindrical contact could be performed and monitored on-line by an infrared camera
- ❖ On-line detection of crack initiation is feasible with a detection threshold of around 200 μm crack depth
- ❖ Multiaxial fatigue prediction models will be validated for this contact type in addition to the commonly used cylindrical-plane contact before extending them to real engineering fretting fatigue.