The Use of 'Pressure-micro Green' Pressure sensitive paper to characterize interface mechanisms between Xray optics and their Heat Exchangers

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Introduction

Uniform pressures between X-ray optics and their heat exchangers have always been assumed due to believing they shared uniform mating surfaces at their interfaces. Until recently exploring these interface mechanisms was not trivial. This poster details findings by the authors who have highlighted by using Pressure-micro Green Paper this is often not the case. The paper allows for two films to be inserted in the interface prior to clamping. Areas which appear deep solid red on the characterizing film are under high pressure and those that experienced little or no pressure remain uncoloured. Significantly higher localized pressures can often be found to be present often at optically critical parts of these X ray- Optics

Pressure- micro green

Supplier – Sensor Products Inc (www.sensorprod.com)

Thickness – 0.2mm, Width – 0.27m

Pressure ranges
- PMG1 - 1 to 50psi (0.1 to 4 Kg/cm^2)
- PMG2 - 25 to 100psi (2 to 7 Kg/cm^2)
- PMG3- 50 to 450psi (4 to 32 Kg/cm^2)
- PMG4- 290 to 1500psi (20 to 105 Kg/cm^2)
- PMG5- 350 to 3,600psi (25 to 250 Kg/cm^2)

Example 1 clamping of ground surfaces

This first example shows a v-block clamped between two ground flat metal plates together with the resulting pressure pattern. It yielded a pattern as expected a uniform 'pink' colouring. The Key is the colour is uniform across the complete interface

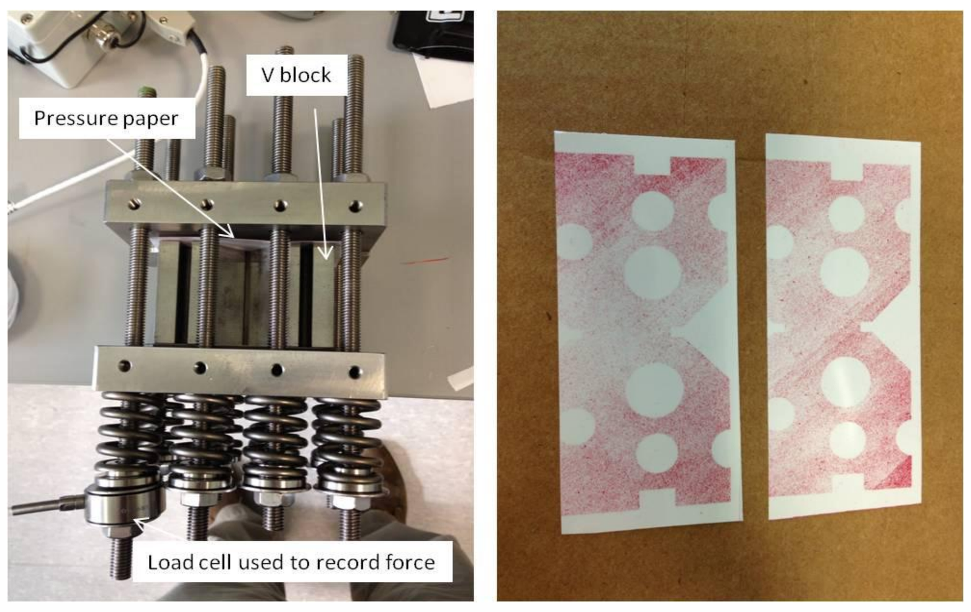

Figure 1 Uniform clamping of ground surfaces

Example 2 Clamping in a current monochromator crystal cage

In this example a current crystal clamping arrangement was investigated. The copper heat exchangers have hollow cavities within them to allow for LN2 flow. These areas have proven to be too weak to resist non uniform deformation. Subsequently the clamping forces applied to a dramatically reduced supporting area leads to significantly higher localised pressures. In this case along the optical surface of a monochromator crystal. If we were to assume only 30% of the interface is supporting the clamping force the localised pressures could be as high as 3 times the predicted average uniform pressure. while large areas remain with little clamping pressure thus reducing cooling efficiency across the interface in these areas.

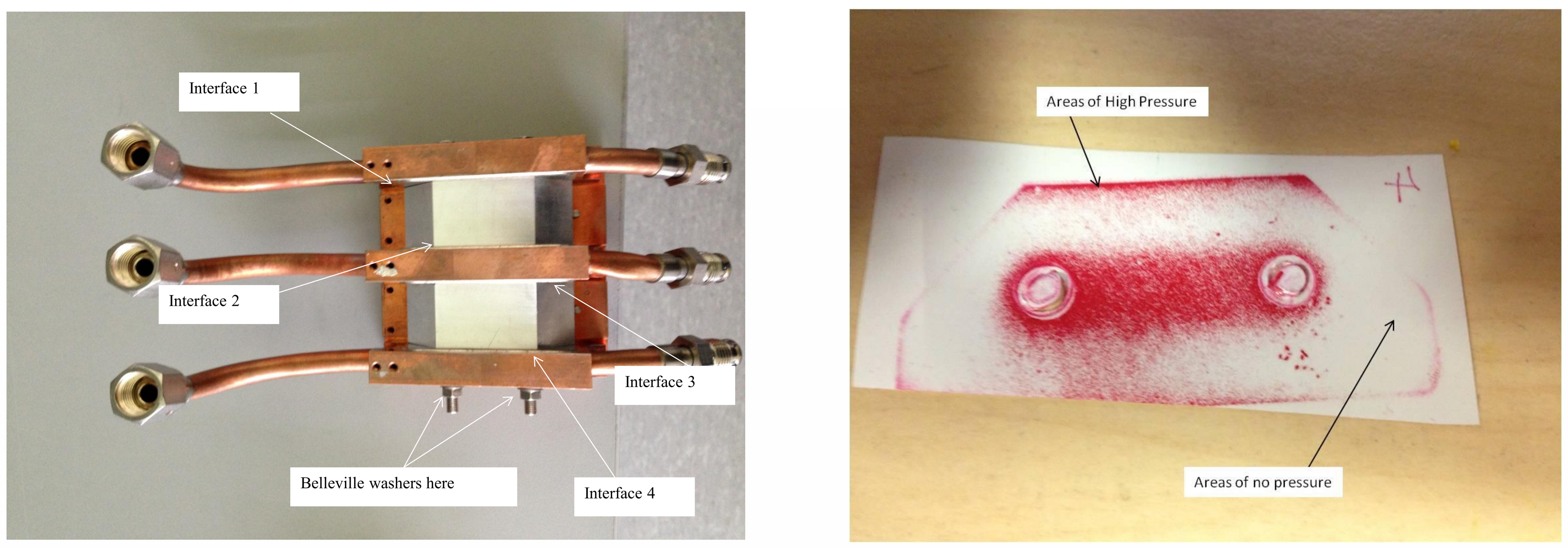

Figure 2 Results of non uniform clamping

Example 3 Clamping of a X-ray Mirror

This example characterizes the clamping interface for an upstream mirror. The two inner strips are the resulting characterization films from the interfaces. Note bottom clamping had resulted in less than 10% intimate contact between heat exchanger and mirror with much higher localised pressure along the mirrors optical surface potentially causing mechanical distortion as well as a poor thermal interface

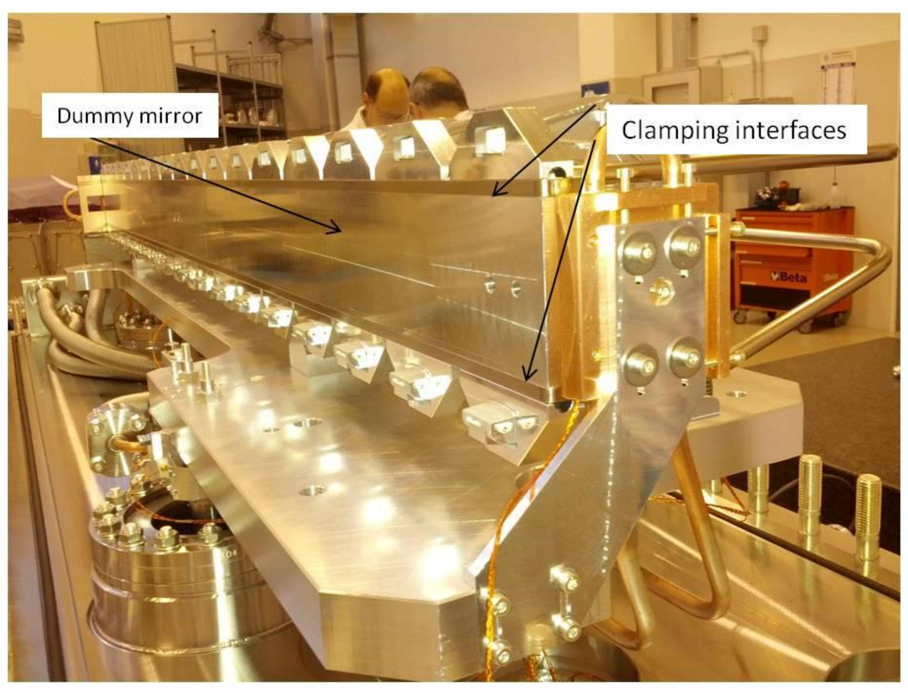

Figure3 Mirror Assembly

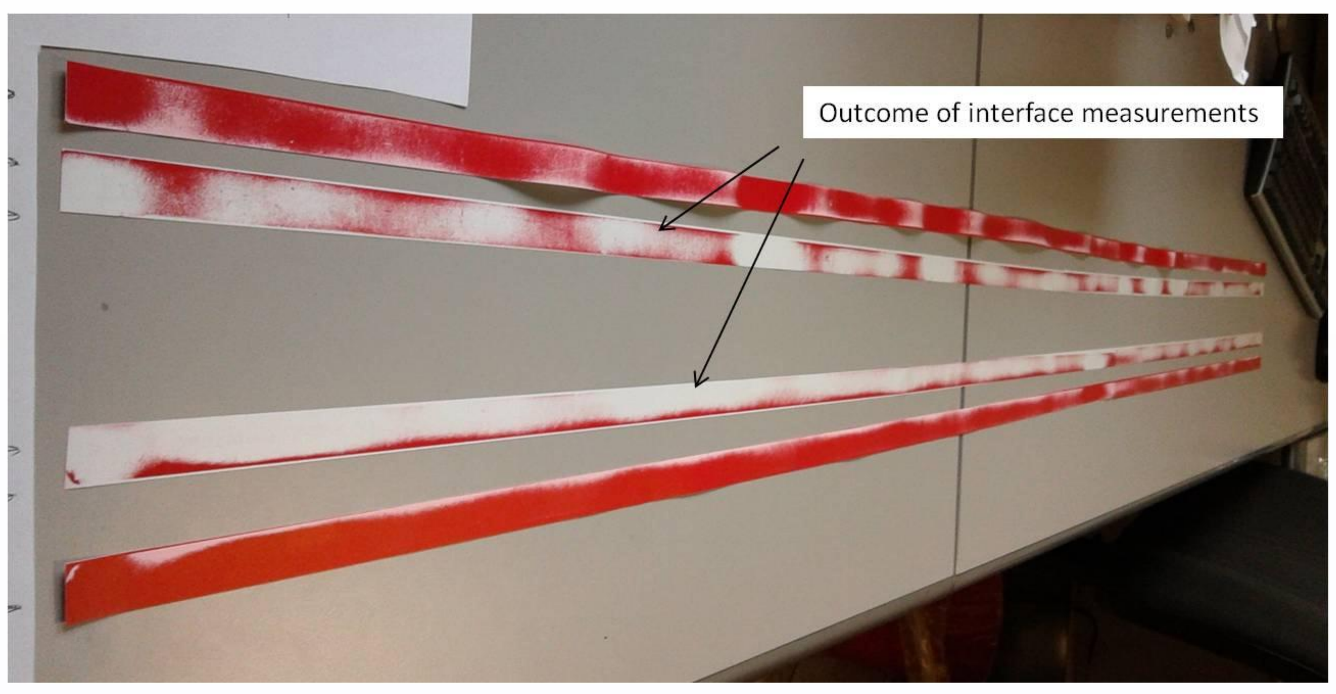

Figure 4 Image of pressure paper characterizing mirror heat exchanger interface

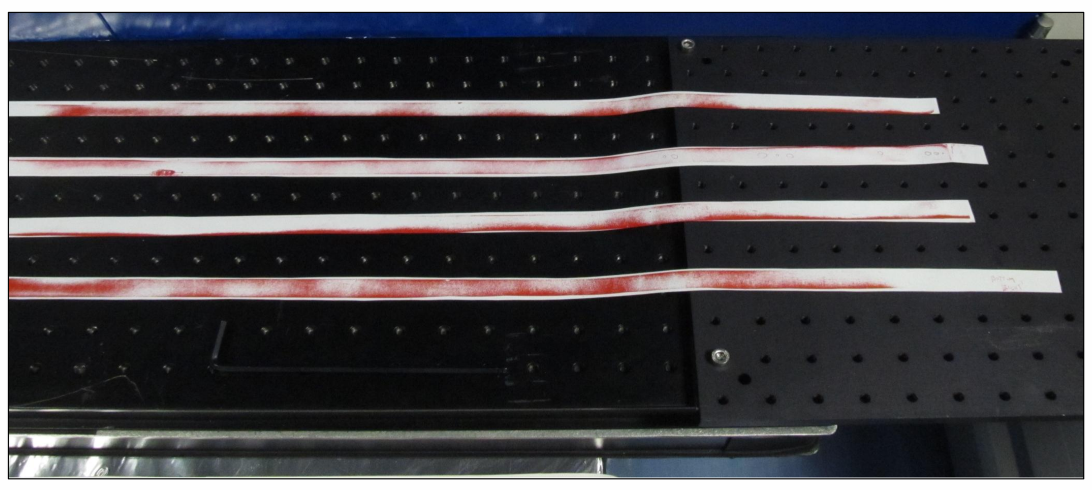

Figure 5 Image of pressure paper showing improvements .

1. First test of suppliers factory
2. Assembled at DLS with nominal force
3. Larger force on two clamps
4. Correction of copper pipe twist

Results of tests on another mirror assembly
- Indium foil must be unmarked
- Flatness and surface finish of copper parts is important – Lapping gives best results

Future work and challenges

Now the ability to characterize these interfaces is possible a greater understanding of what effects these interface mechanisms can be determined. This will allow for new methods of clamping or clamping regimes to be explored and their subsequent improvements. This will allow for a greater understanding of what can be expected from these thermal interfaces and also give us an insight into potential mechanical distortion of these optics due to non uniform clamping. Understanding these mechanisms will continue to become of greater and greater importance as the worlds Synchrotrons continue to develop greater and greater X-ray fluxes

For more information please visit www.diamond.ac.uk or contact Dr Peter Docker at Peter.docker@diamond.ac.uk

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