# Development of a low cost system used to align 3D microfluidic channels

Mieszko Jaskiewicz; Supervised by Dr Jinju Chen, Dr Lucy Eland and Saikat Jana
Student Number: 140236499; School of Mechanical and Systems Engineering; M.Jaskiewicz1@newcastle.ac.uk

Newcastle University

## Introduction

Microfluidics devices play an important role in testing biological samples. They are microscopic systems which allow for processing and manipulation of very small ($10^{-9}$ to $10^{-18}$ litres) amounts of fluids. This is done inside channels which have dimensions ranging from tens to hundreds of micrometres. These channels are moulded inside a polymer called Polydimethylsiloxane or PDMS.

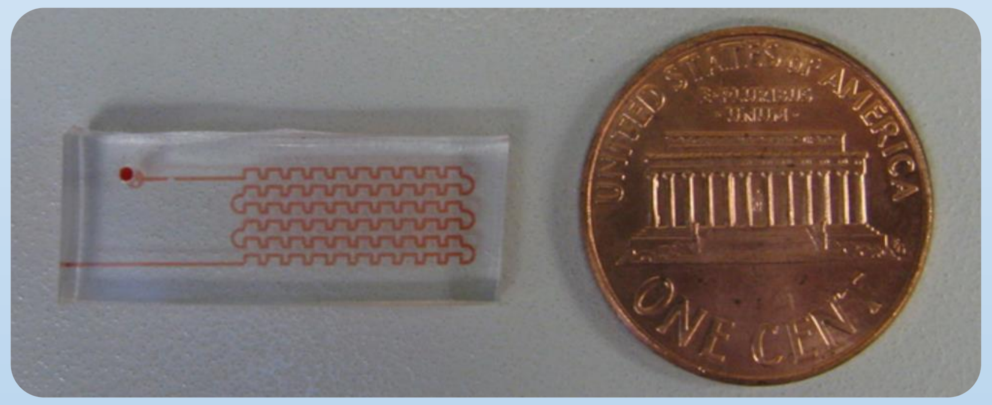

**Figure 1. Microfluidic device filled with red dye compared to one American penny (approximately the size of 10 pence coin)**[1]

For more complicated applications multiple PDMS layers have to be connected together. The production of these devices requires very fine scale movement and alignment of marks, something impossible to achieve by eye.

## Aim

Design and construct an aligner which accurately aligns two PDMS layers together to form a 3D microfluidics device. The system will involve the use of:

- Optics, to magnify the parts
- Mechanical controllers, to align two PDMS layers together

## Design

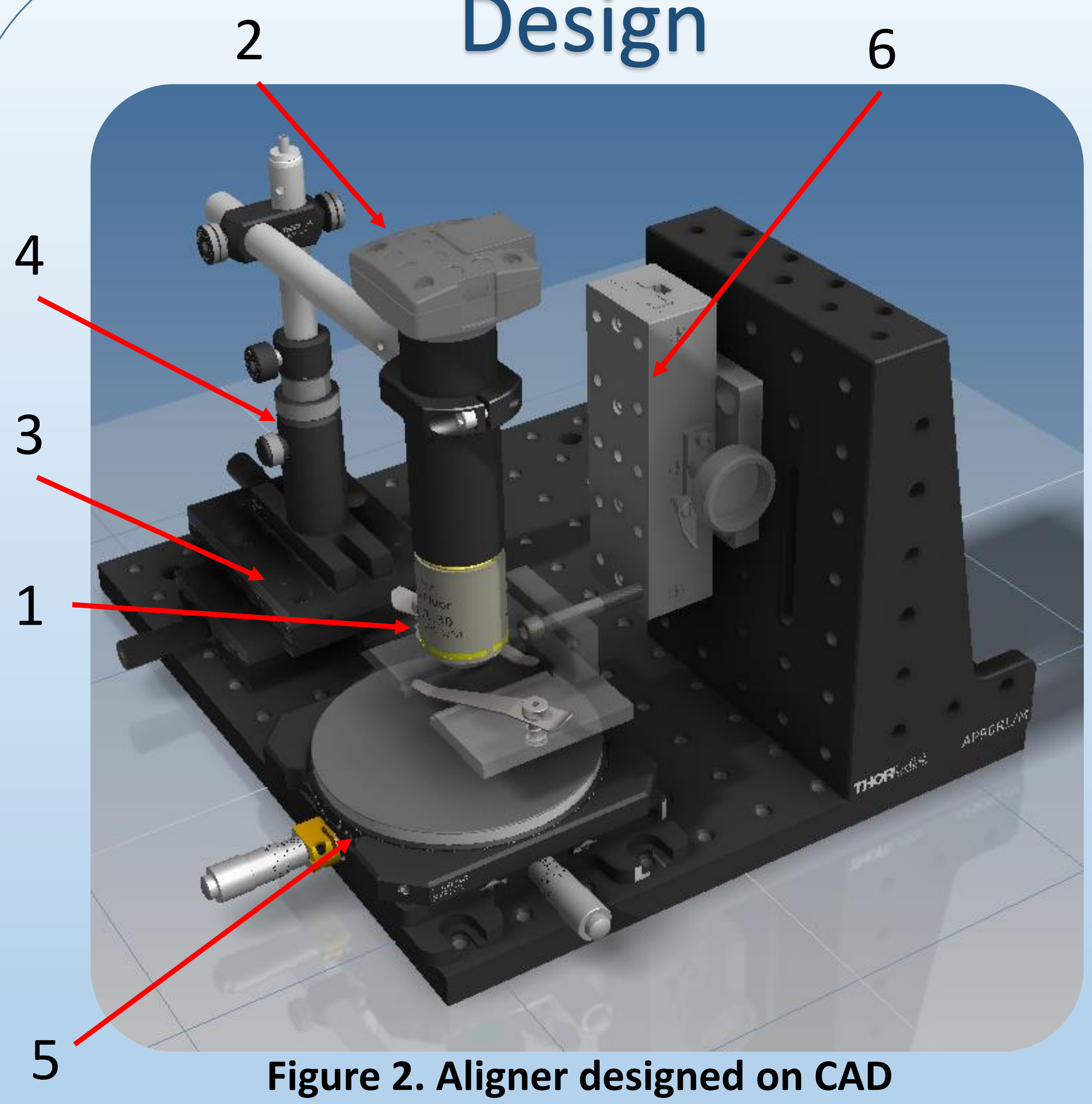


**Figure 2. Aligner designed on CAD**

**Optical System**

1. A Nikon 4x zoom objective - does not need a backlit pad to produce an image
2. Digital camera - records and reproduces the image on a computer screen
3. Two translation stages - allow for the objective to be positioned above the alignment marks
4. Post holder - permits 16mm movement in vertical direction making it easy for the objective to focus on the alignment marks

**Mechanical System**

5. XYθ Stage - holds one of the PDMS layers, which can be translated in both the x and y directions as well as being rotated
6. Z Stage and Slide Holder - holds the other PDMS layer and allows for vertical translation only. Once the marks have been aligned the slide holder is moved down and the two PDMS layers are joined together

## Finished Aligner and Testing

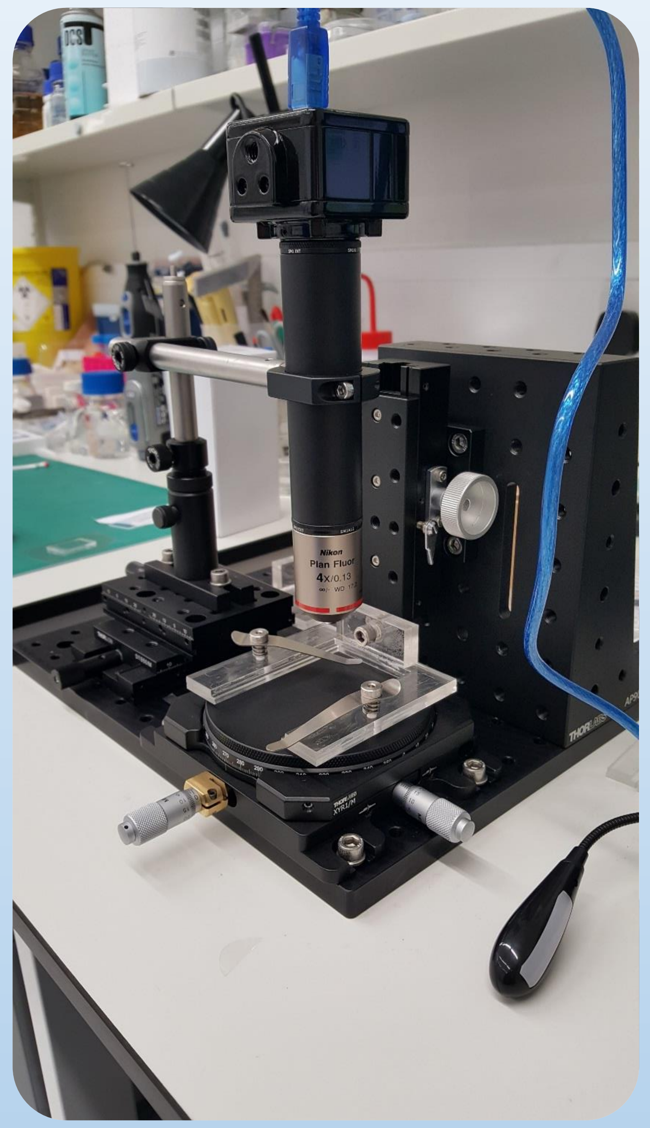

**Figure 3. Finished Aligner**

Before constructing the optical system the mechanical system was tested using a handheld digital microscope.
As seen in Figure 4 the mechanical system works as expected with the alignment marks overlapping each other.

**Figure 4. Illustrates two alignment marks prior and after alignment**

After, both the mechanical and the optical systems were tested. As seen in Figure 5 the objective could not focus on both PDMS layers at the same time.

This problem can be potentially resolved by one of the layers being less few hundred microns thin.

**Figure 5. Illustrates two alignment marks but with only one being in focus**

## Conclusion

At the end of the project fully functioning mechanical system has been designed and tested. Further tests need to be performed to optimise the design of the optical system and to make sure it is working correctly.

**Reference:**

1. Texas Tech University,. *Http://Today.Ttu.Edu/Images/2012/03/Drug-Testing-Lg.Jpg*. 2016. Print.