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Accurate micron-scale modification of AFM cantilevers

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(i) Introduction

Atomic force microscopy^[1] has provided the modern researcher with the ability to perform accurate force measurements between a probe and a surface.^[2] The data obtained can be used in the development of biosensors^[3], surfactants^[4], and materials with enhanced properties^[5], to name only a few applications. The atomic force microscope (AFM) is undoubtedly suited for making repeated force measurements. Standard AFM cantilevers can be modified through the attachment of a colloid probe such as silica^[2,6], and employed in the analysis of forces between surfaces.

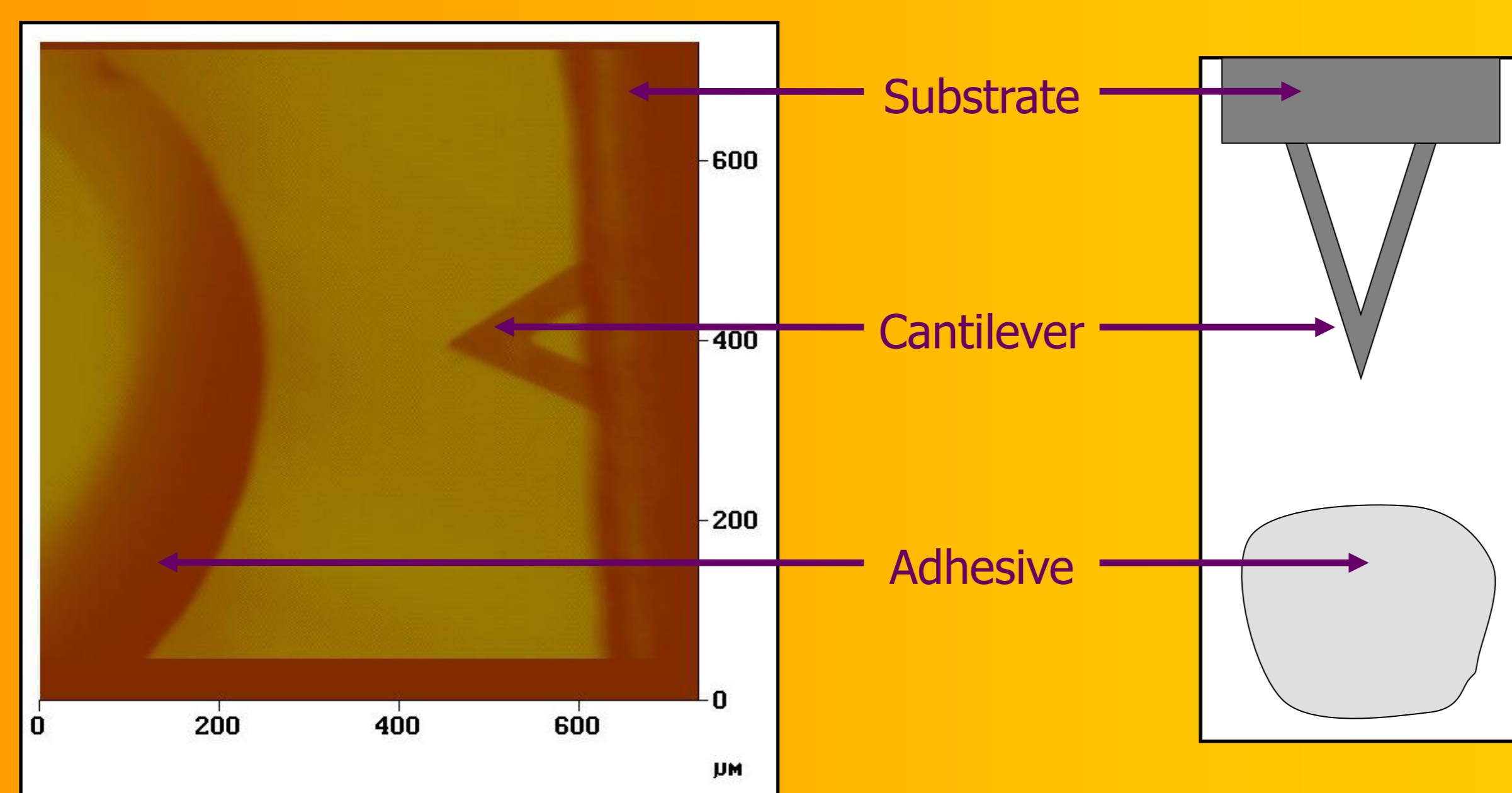
(iii) New method and advantages

A technique has been developed whereby AFM cantilevers can be modified with a probe using the Dimension 3100 Nanoscope AFM as a micromanipulation tool. The procedure can be followed in real time using the video camera attached to the AFM. The piezoelectric tube system of the AFM allows for controlled movement of the cantilever relative to the sample surface. UV-curable adhesive (Norland Products) was chosen in preference to epoxy resin.

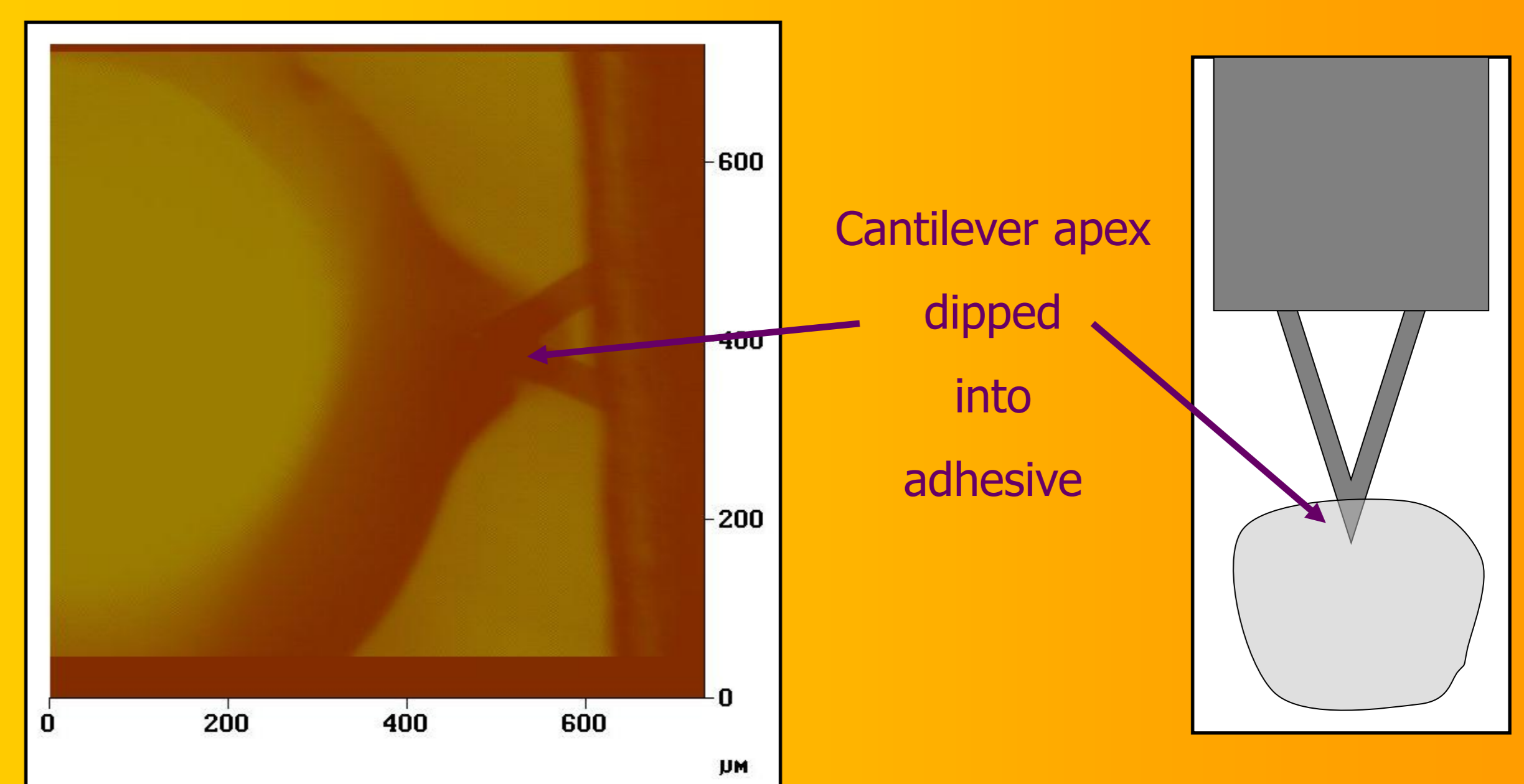
(ii) Previous method and limitations

Resin-based^[2] or glass bond adhesives^[6] are suitable for probe bonding, as they are insoluble in water once set. However, such adhesives often require heating to reduce their viscosity, which makes the procedure quite difficult to carry out. The particle is usually attached to the apex of the cantilever, so that measurements can be performed with optimum force resolution. Particle attachment is traditionally carried out under an optical microscope using thin wire as a guide.^[7,8] However, there is no guarantee that the colloid particle has been accurately positioned on the apex of the cantilever.

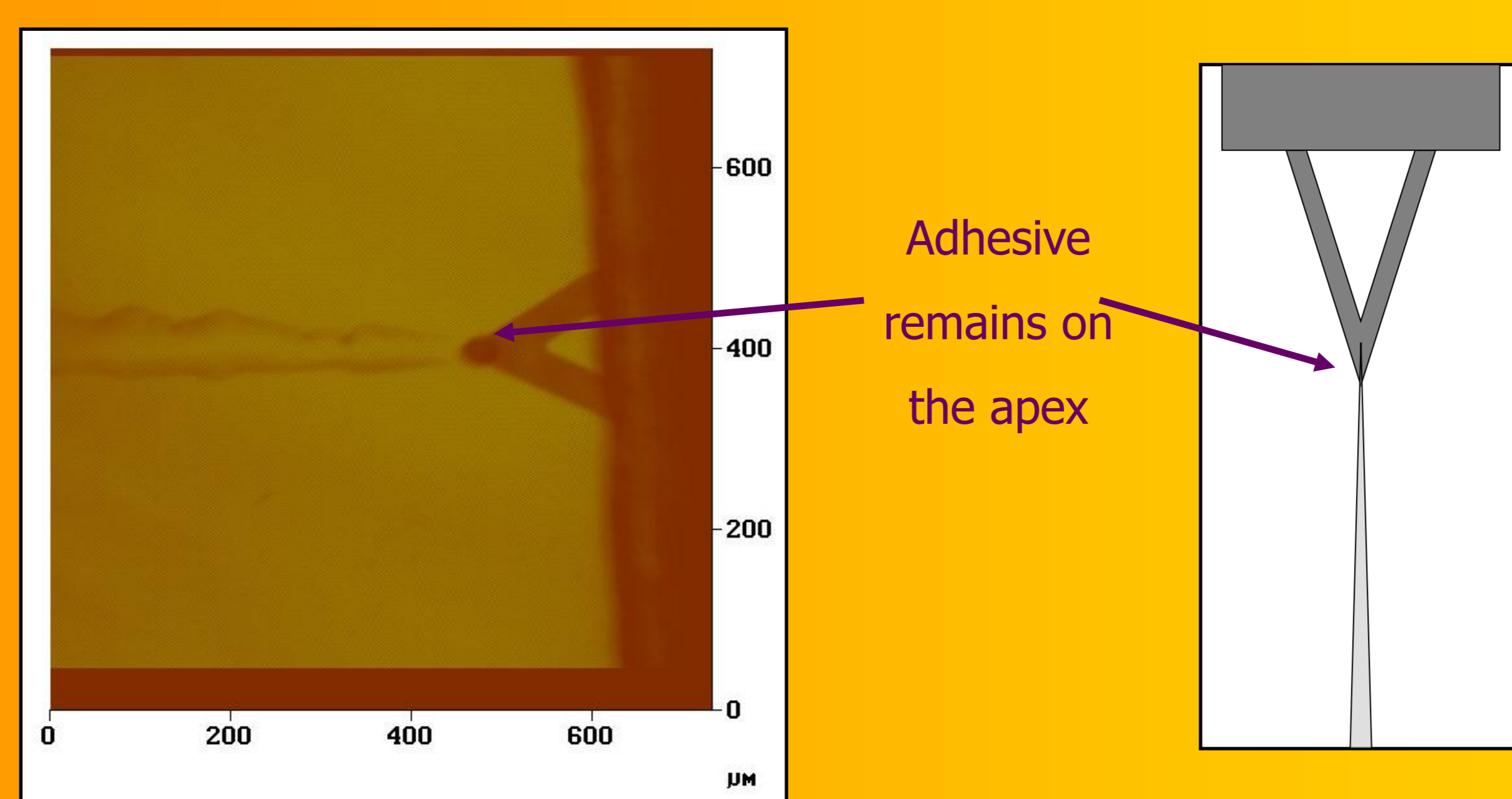
This does not require the use of elevated temperatures and also offers excellent chemical resistivity against water, acids, and some organic solvents.^[9] The AFM was used to attach a 6.62 μm diameter colloidal silica particle (Bangs Labs) to the apex of the AFM cantilever using UV curable adhesive. The following figures are video camera images from the AFM (left-hand side) and cartoon representations (right-hand side), showing the procedure as it was performed.



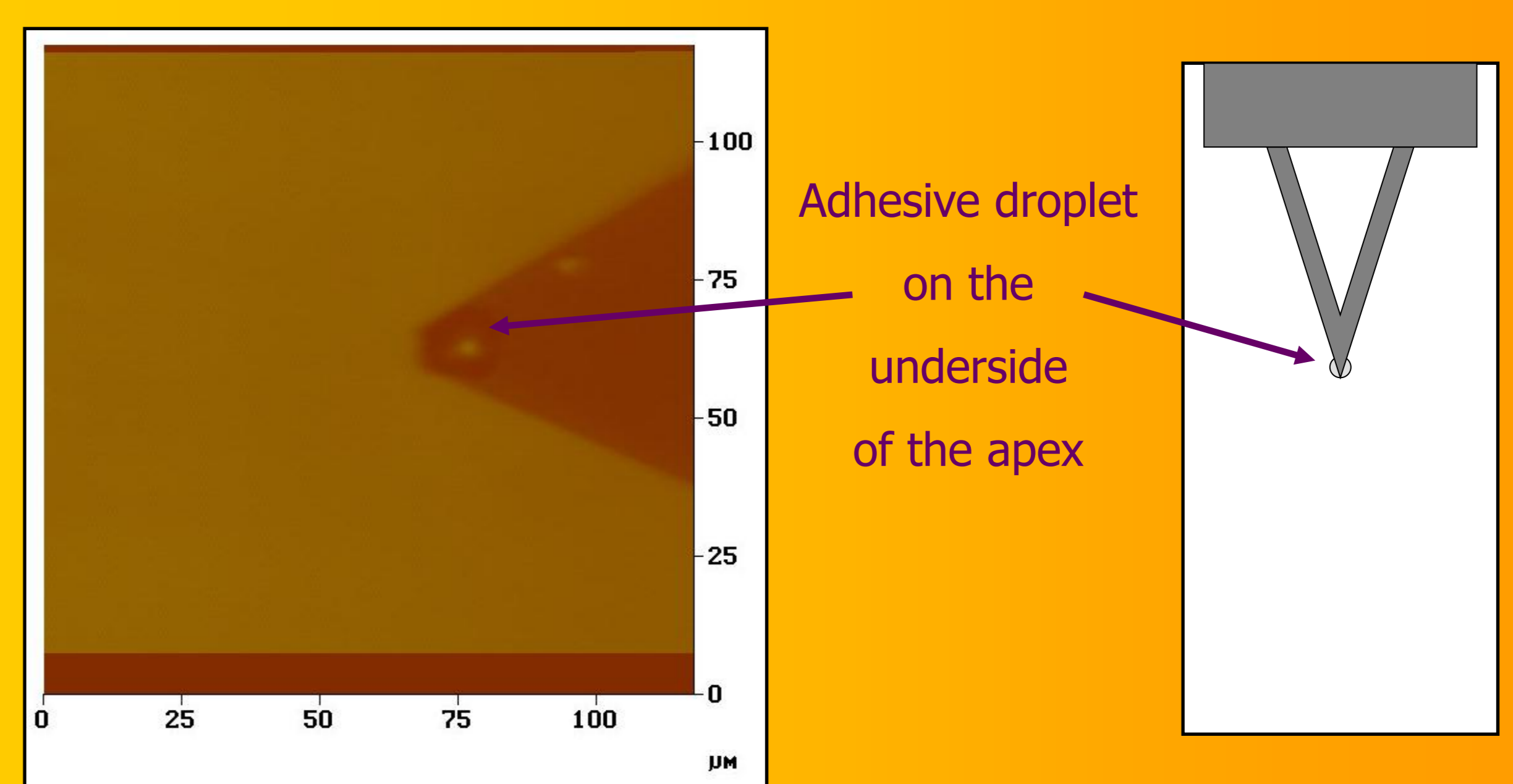
1. A droplet of adhesive is placed on a glass microscope slide, and the AFM cantilever is manoeuvred close to it.



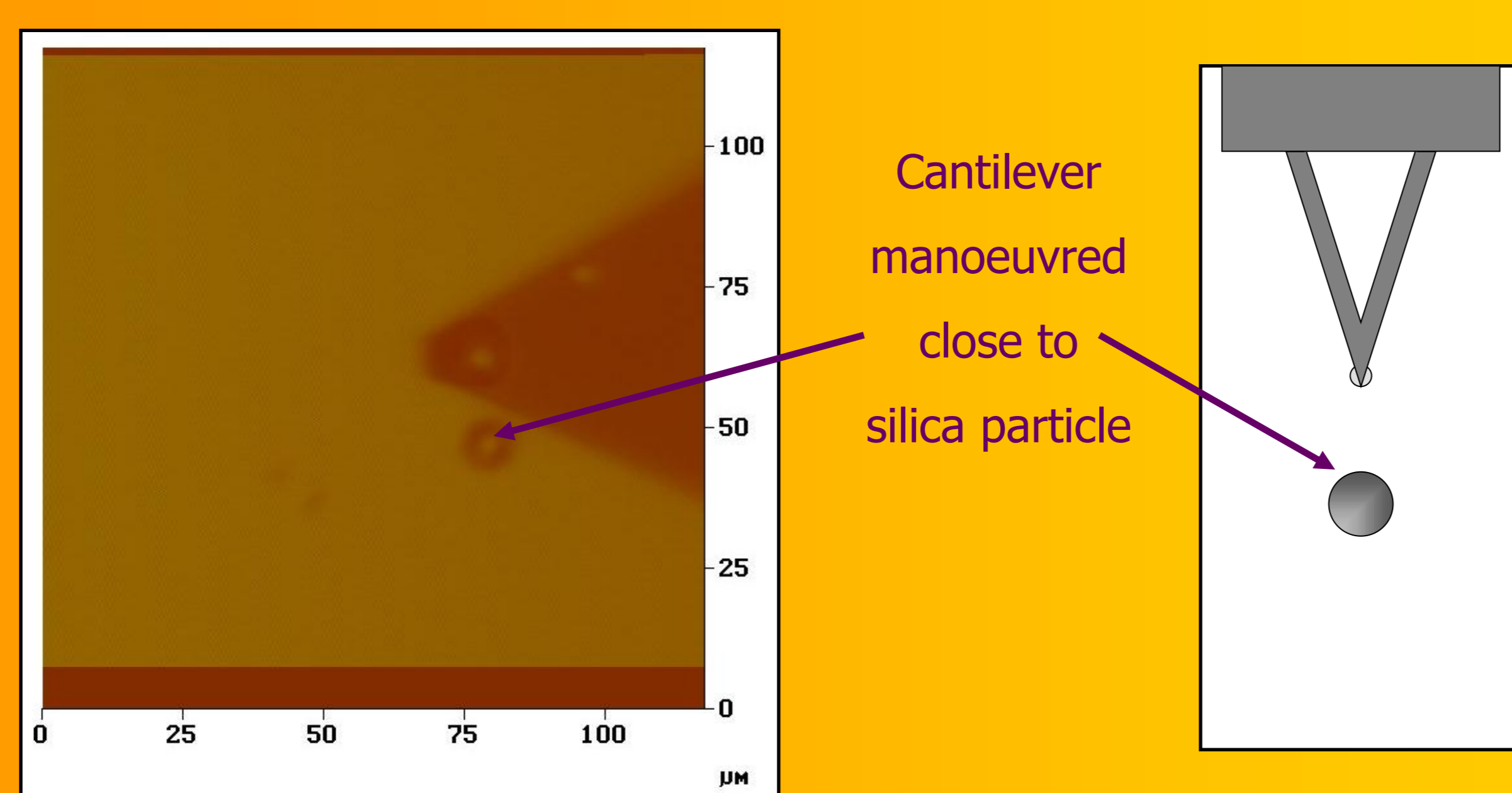
2. The cantilever is lowered into the droplet of adhesive until the apex has been fully immersed.



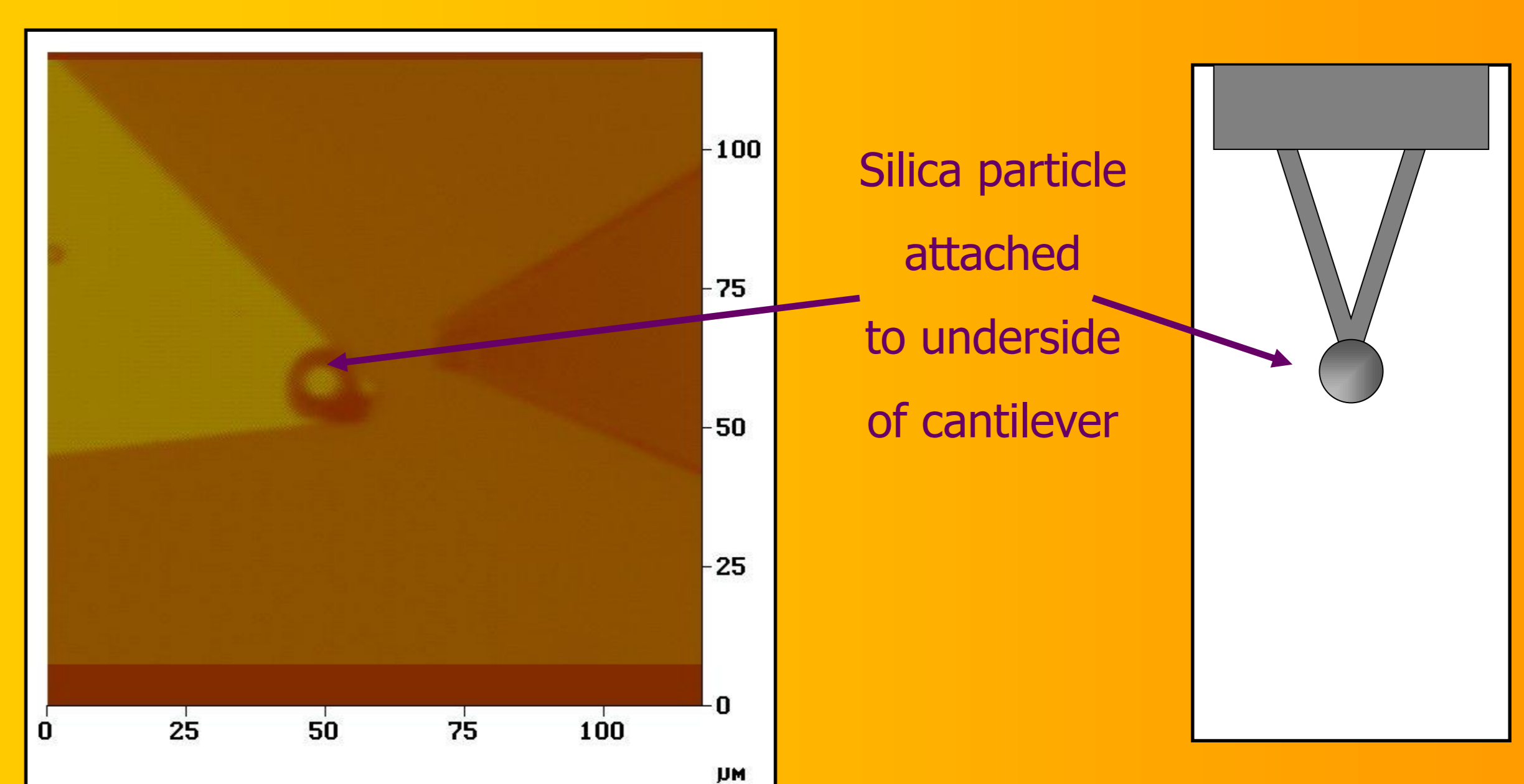
3. The cantilever is dragged away from the droplet, creating a line of adhesive along the surface of the glass microscope slide.



4. The cantilever is raised away from the line of adhesive, and a small droplet of adhesive remains on the underside of the apex.



5. The cantilever is manoeuvred close to a silica particle. The cantilever apex is lowered onto the particle, and UV light is applied.



6. The UV light cures the adhesive, bonding the particle to the apex of the cantilever, which is suitable for force measurements.

(iv) Conclusion

The Dimension 3100 Nanoscope AFM has successfully been used to modify an AFM cantilever with a colloidal silica particle, using UV curable adhesive as a bonding agent. The procedure is easily repeatable and can be performed relatively quickly. Moreover, when surface interactions are performed, the measurements will have optimal force resolution, due to the accurate positioning of the particle at the apex of the cantilever. This is a definite advantage over the use of an optical microscope for cantilever modification.

(v) References

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