Dispensing of highly viscous liquids using GeSiM microdispensers

Liquids and Limitations

GeSiM's piezoelectric actuated microdispensers are commonly used to eject droplets of water or solvent based liquids. The properties like the density and the surface tension of these liquids may be very different but the viscosity is almost lower than 5 mPas. This value is the limit of the standard microdispensers from GeSiM for the droplet ejection at room temperature. Dispensing such liquids droplets with diameters between 50 and 100 µm and velocities up to a few meters per seconds are produced.

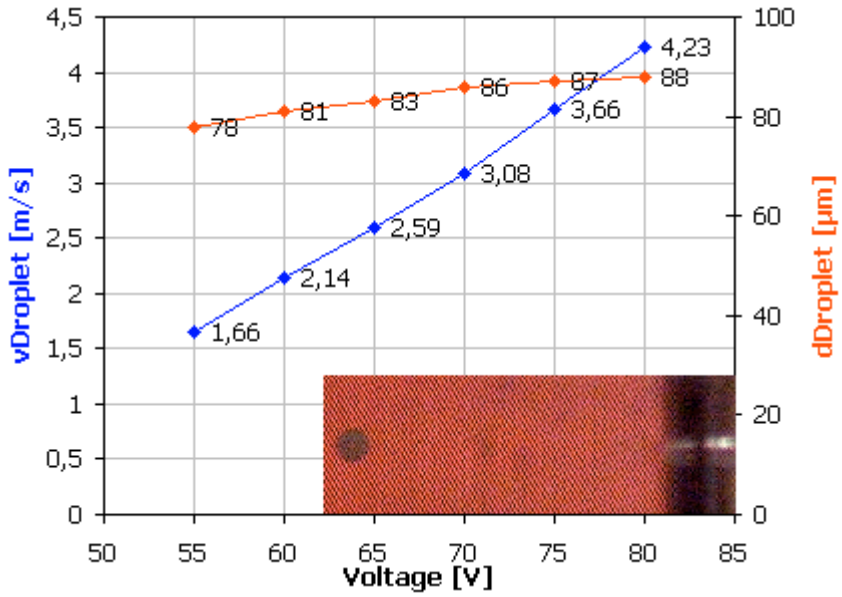
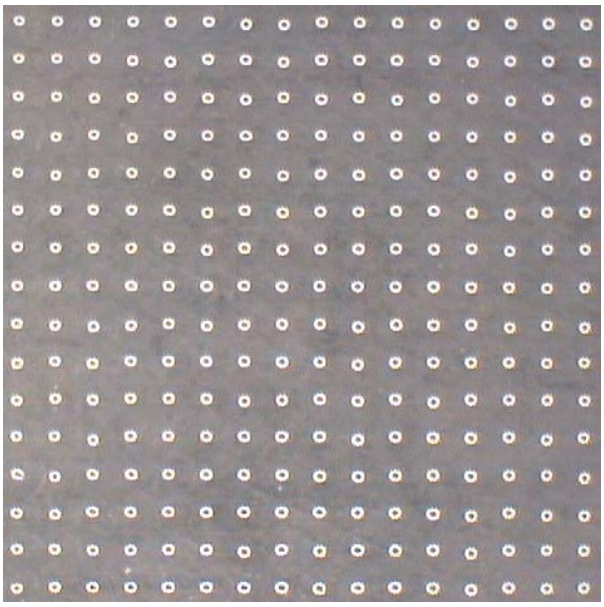


Fig. 1: Droplet velocity (blue line) and diameter (red line) as a function of the excitation voltage at about 90 °C for UVO-114

Some interesting liquids like adhesives often have higher viscosities than 5 mPas. To dispense this class of liquids the heating of the microdispenser is necessary to lower the viscosity. If a certain liquid can be dispensed with a GeSiM microdispenser depends on how fast its viscosity decreases with increasing temperature. If the viscosity of a liquid depends strong on the temperature it is recommended to heat such liquid to values above the room temperature. Doing this changes in room temperature do not affect the dispensing behavior. The GeSiM microdispenser should not be heated to temperatures above 120 °C. This means that the viscosity of a certain liquid should not be higher than about 5 mPas at 120 °C.



Two liquids that have been dispensed successfully are the uv curable adhesives OG169 and UVO-114 from Epoxy Technologies. The viscosities at room temperature are 82 mPas for OG169 and 300...700 mPas for UVO-114. The dependence of the droplet velocity and diameter on the excitation voltage for UVO-114 can be seen from Fig. 1. The small picture inside Fig. 1 shows a single droplet of the adhesive in front of the dispenser nozzle.
Fig. 2 shows an array of epoxy spots on a glass slide. The spot size is about 200 µm and can be varied using different dispenser settings. Although the viscosity of OG169 is much lower than that of UVO-114 a higher temperature is needed to dispense this adhesive.
Other liquids have been tested like glycerol and some two component epoxies. In the case of the two component epoxies both components have been dispensed with two different micropumps. The mixing of the epoxy than takes place on the substrate. 301-2 from Epoxy Technologies has been successfully dispensed and cured.

Fig. 2: Array of UVO-114 with a spot diameter of about 200 µm on a glass slide

Types

Two different types of heatable microdispensers are offered by GeSiM with respect to the liquid supply. One has a capillary inlet that can be connected to a tubing. The other is designed so that a commercially available 3 cm³ disposable reservoir system can be connected to the microdispenser using standard Luer-Lock-fittings. A seperate heater for this reservoir type exists. The reservoir can be supplied with vaccum and pressure from an external source. The pressure is used to prime the microdispenser while a slight vacuum helps to get the nozzle free from the adhesive.
Fig. 3 shows a heatable dispenser (housed in PEEK) at the bottom of the picture together with a 3 cm³ disposable reservoir system and the connector to the pressure supply (yellow).

Modified microdispenser
Because of the fact that the standard dispensers are limited to a viscosity of about 5 mPas a modified dispenser has been developed that can handle liquids with up to 20 mPas. Typical droplet diameter are in the same range as for the standard element. Together with the option of heating the dispenser has a higher working frequency than the standard element.

Applications
One possible application is of course the dispensing of small amounts of adhesives. But of course other applications are possible like dispensing oils. To solve more complex dispensing tasks the microdispensers can be used together with a modified GeSiM Nano-Plotter.

X-Y-Z-Station
The Nano-Plotter is a pipetting device for sample volumes in the range of about one hundred picoliters up to several micro liters using the micropipettes developed by GeSiM. The footprint of the device is 620 x 520 mm. The x-y-unit can move with velocities up to 500 mm/s, the maximum speed of the z-axis is 80 mm/s. For the x- and y-axis a position control is integrated.

Fig. 3: GeSiM microdispenser with 3 cm³ disposable reservoir system

With the help of this a precision of 20 µm can be realised. The usable workplate dimensions are 300 x 300 mm depending on the size of the tools mounted at the roboter head. To meet higher needs for positioning accuracy additional precision stages can be mounted directly on the workplate to make this part of the workplate an area ready for more precise positioning operation. A newly developed z head can carry up to four different dispensing or pick and place tools using four independent controllable z-axes. One or more z-axes can be rotatable. The grid of the individual z-axes is 22 mm.

Accessories
The adjustment between the individual tools and the objects of the workplate can be realised using an image processing system. A video microscope is mounted on the roboter head. Using this the dispense and assembly positions can be teached for the usage in control programs of the machine. It is also possible the recognize and correct the position and orientation of the chips in the source tray or during transfer from this to its target position. Furthermore the quality of the dispensing or assembly process can be controlled with this image processing system.

An optional z-level sensor can measure the individual height of each object on the workplate. It is possible to use the values of this procedure later for the z-positioning of the different tools mounted at the roboter head in assembly programs.

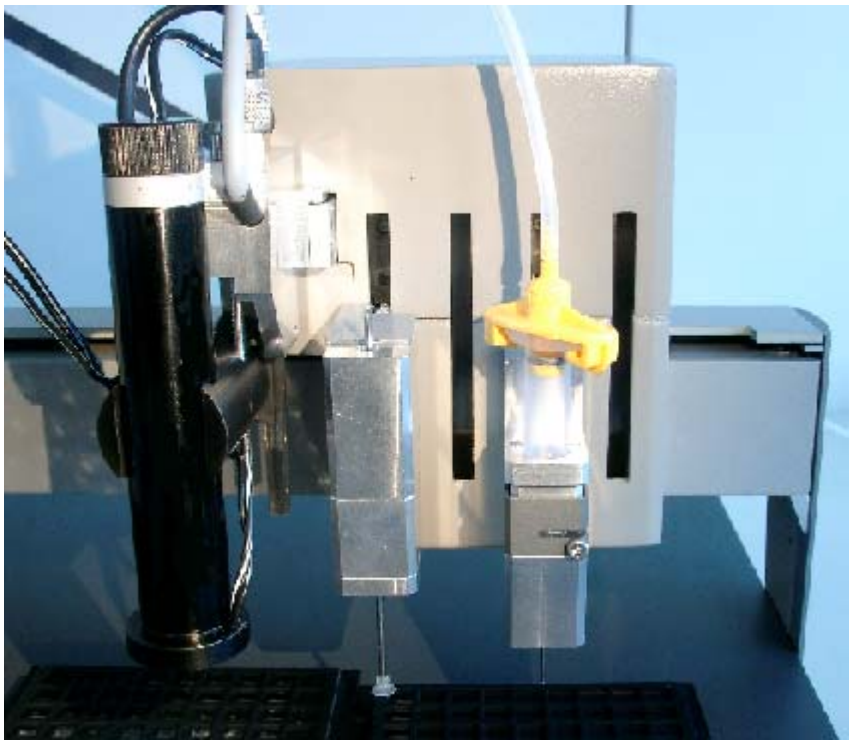


Fig. 4: Z-head with dispenser, pick and place tool and video microscope

Nearly every handling tool that fits this pitch can be adapted to the roboter head, e. g. common dispensing systems consisting of pressure source and magnetic valve.

A prototype uses a vacuum handling tool for pick and place operation which is connected to a vacuum pump. To handle non planar and more complex parts other pick and place tools can be integrated in the machine. Different tools using various principles are commercially available.