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The Use of Fluid Dispensing Equipment in Conservation Treatment

ABSTRACT

Controlled fluid dispensing equipment (widely used in semiconductor assembly industry) has been successfully adapted for a number of conservation treatment applications practiced at the New York Public Library's Barbara Goldsmith Conservation Laboratory on flat and bound paper items as well as on materials of other substrates found in library and archival collections. Advantages of fluid dispensing equipment include precise and repeatable control of the amount, rate, spread, and flow-pattern of adhesives, consolidants, solvents, lubricants, and other liquids, including loss compensation materials, used in conservation treatment. The amount of fluid deposited may be adjusted from individual dots, to a continuous bead varying in size from as small as 0.01 mm in diameter, to thick ribbons 3–5 mm wide. Suitable fluids include starch pastes and paste mixtures, modified celluloses (aqueous and solvent-based), PVAs, acrylic resins, many organic solvents, suspensions of cellulose fibers, cyanoacrylates, gelatin, and parchment sizes. The availability of tips of different sizes, shapes, and materials provides for significant adjustability. For paper and membrane repair operations, fluid dispensing equipment gives a high degree of precision to traditional edge repairs, fiber bridge mends, micro pulp fills with fiber suspensions, as well as other methods particularly suited to the equipment, such as micro-dot "welding" of tears. Other applications include the consolidation of flaking media and structural materials, as well as some types of leather repair using solvent/modified cellulose solutions of different viscosities.

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This talk and digital video presentation illustrated the use of controlled fluid dispensing equipment for a number of conservation treatment applications at the New York Public Library (NYPL) in the Barbara Goldsmith Conservation Laboratory. The equipment is used in industry to adhere electronic components to circuit boards and to apply adhesives, lubricants, or coatings of varying viscosities with precision in automated and manual assembly operations.

Fluid dispensing equipment is not new to conservation. Abigail Quandt in her 1995 report on new conservation treatment techniques for parchment credits Dr. Robert Fuchs with introducing a fluid dispensing device manufactured in Germany—the *Dosiergerät* or "Dosing Device"—in 1994 for use in paintings conservation (Quandt 1995). She also notes the use of the device for consolidation of paint and other media on parchment by Ulrike Bürger at the State University Library in Bern, Switzerland. The use of this equipment does not appear to be widespread in either Europe or the United States despite the considerable advantages it offers for many conservation applications.

ADVANTAGES OF FLUID DISPENSING EQUIPMENT

Advantages of fluid dispensing equipment include precise and repeatable control of the amount, rate, spread, and flow-pattern of adhesives, consolidants, solvents, lubricants, or other liquids used in conservation.

A wide range of fluids may be used with the equipment; materials with viscosities ranging from that of a thick paste to a watery-thin solvent may be deposited with accuracy. The pattern of fluid deposited may be adjusted from that of individual micro-dots to a continuous bead as small as 0.10 mm in diameter to thick ribbons 4–5 mm wide. Spray nozzles are also available which apply a controlled spray within similar size ranges.

FLUID DISPENSING AT NYPL

The fluid dispensing system in use at NYPL is manufactured by EFD Inc. (http://www.efd-inc.com) and consists of a model 1500XL controller, which modulates air flow and vacuum suction, a compressor, variously-sized syringe bodies to contain fluids, and a selection of syringe tips in a wide range of sizes and configurations.

CONTROLLER

The heart of the fluid dispensing system is the controller (fig. 1), which permits adjustment of the time and pressure for the dispensing action and determines whether the pulse is of a pre-determined duration or is controlled manually. Several different models are available, differentiated by varying viscosity capacity and by the provision for programmed sequences of operations.

Since most conservation operations require individual control and judgment rather than sequenced repetition of uniform deposition (as found in circuit board assembly, for example), units with less sophisticated programming capability may be adequate for many treatment applications. On the other hand, conservators frequently use fluids with widely varying viscosity ranges. The more versatile models that accommodate thick pastes to very thin solvents or lubricants may be preferable choices for a treatment facility. Hand-powered fluid dispensing equipment is also available for field use, and though some aspects of the control system are lacking, this type of equipment might have applications in architectural or object conservation. The product cycle appears to be quite rapid in this industry; individual models are superseded and modified continually.

The controller consists of a series of valves and a proportional regulator to control the supply of compressed air supplied to the syringe. Airflow is initiated by a foot pedal switch or a finger trigger on the syringe. Most units have a small internal adjustable vacuum pump which activates at the end of the deposition cycle for thin fluids, counteracting capillary action within the syringe needle or the surface tension of a drop at the needle tip which might cause additional liquid flow after the compressed air stroke has completed. This vacuum action eliminates any overflow or dripping during the operation and permits uniform amounts of low viscosity fluids to be deposited with great precision. This feature has been especially valuable when applying thin organic solvents in a controlled manner.

Fig. 1. EFD controller 1500XL fluid dispensing unit with compressed air gauge (at left) and vacuum control gauge at right; regulator valve and program timing controls at center.

COMPRESSOR

Most compressors can be used with fluid dispensing equipment. While the amount of compressed air required is minimal, filtration of oil or other contaminants is essential. Either an oil-less compressor or adequate oil and condensate filtration is needed, together with a tank to minimize variation in airflow to the controller. A quiet unit, a remote location, or proper sound insulation for the compressor is strongly preferred in a laboratory environment. NYPL has used enclosed Jun-Air compressors for several decades without difficulty.

SYRINGE

Syringe barrels (fig. 2) are available in several sizes ranging from 3 cc through 55 cc. A special, pencil-shaped

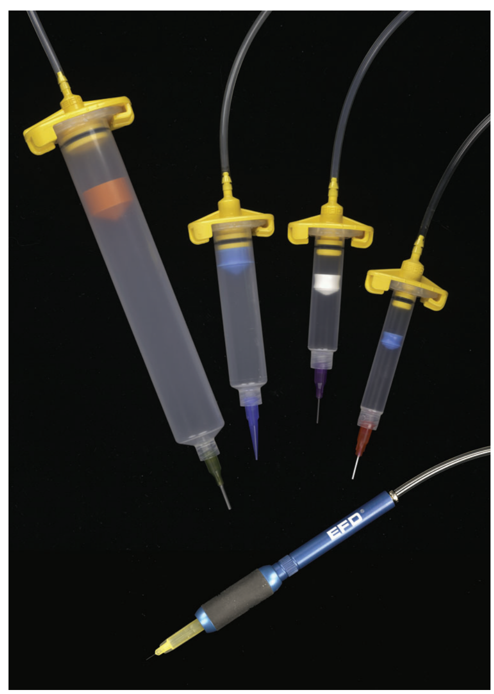

Fig. 2. Syringe barrels with capacities ranging from 3–55 cc (above) and the “Micros” finger-activated pen unit (below) used for fluid quantities of 1 cc or less.

syringe—the "Micros"—is also available, having a smaller barrel for 1 cc quantities of liquid and incorporating an integrated finger-activated button switch. Pistons of Teflon or polyethylene with different levels of stiffness are available to provide the appropriate degree of responsiveness to air pressure for different viscosity fluids. Automated rapid filling devices are available for use in a production environment, but these are not necessary for most small-scale conservation applications. Manual loading of a syringe using a supplied spatula, pipette, or squeeze bottle or by pouring less viscous fluids into a syringe with a funnel or beaker is quite manageable.

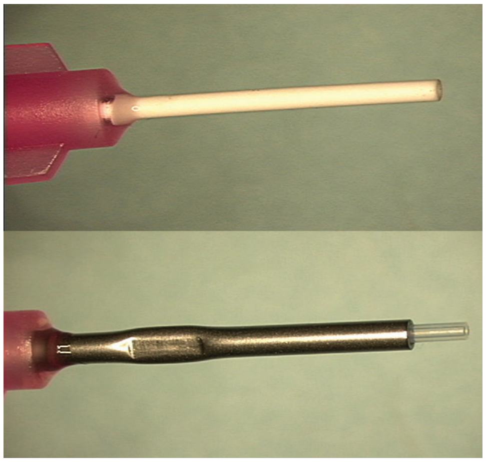

Fig. 3. Two examples of range of applicator tip types: flexible polyethylene tube tip (above) and clear Teflon-lined steel tip (below). Both are non-abrasive and may be trimmed and shaped.

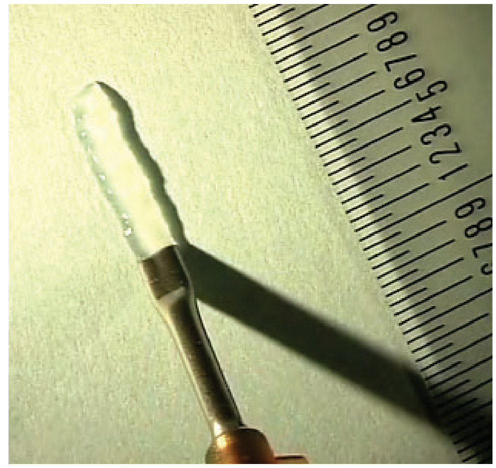

Fig. 4. Oval or flattened tube-type tip used to apply larger ribbons of more viscous fluids. Scale shows 0.5 mm increments.

Adhesives and consolidants may be sealed and stored in the syringes for future use depending on the stability of the fluid involved and whether component solubility is of concern. Syringe barrels are generally made of polyethylene, which may limit use with some solvents. However, barrels fabricated from other materials have been available on a sample basis and may be manufactured if demand becomes sufficient.

APPLICATOR TIPS

The versatility of the equipment for fluids and applications is provided by an extensive variety of tips available in more than a hundred sizes, shapes, and materials. The most useful tips (fig. 3) for NYPL have been the soft, flexible polyethylene tubing tips available in four diameters (0.5–1.65 mm) and two lengths. These may be cut or shaped to size and maneuvered into difficult areas while limiting potential for surface damage to an artifact. Stainless steel tips in a wider range of diameters and configurations (angled, chamfered, Teflon-lined—for use with cyanoacrylates and other types of adhesives) have greater potential for surface damage during use, but good technique and control reduces risk. Oval tips (fig. 4) permit thicker 4–5 mm flat ribbon deposits of adhesive to be extruded in an even manner. Funnel-shaped plastic tips (fig. 5) without the constriction of a narrow needle point are quite useful with fiber suspensions and pulp fills, preventing clogs. Brush tips are also available, though the commercially available bristles are made of coarse nylon and are of limited utility in conservation. Additional development and adaptation is possible in this area. Combining the precision fluid control of the EFD with a range of soft natural or synthetic brushes such as those traditionally used in conservation treatment would further extend the conservation applications of this equipment. Used with an empty syringe, the fluid deposition unit can provide either continual streams or intermittent bursts of controlled filtered air with the force, area, or volume required for

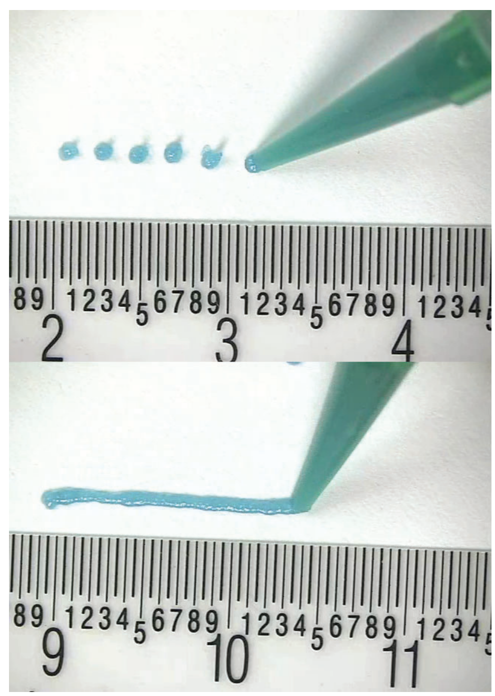

Fig. 5. Tip shown is funnel-shaped plastic useful for fiber suspensions and thicker fluids. Two fluid application methods—regulated micro-dots dots of programmed amounts and a continuous line or bead of fluid determined by air pressure, tip diameter, and movement of the syringe unit.

cleaning or dust removal operations. Tips and syringes may be cleaned for repeated use but are intended and priced for disposal after use.

APPLICATIONS IN CONSERVATION

Fluids used with the EFD equipment at NYPL have included starch pastes and paste mixtures, modified celluloses (aqueous and solvent-based), PVA-type emulsions, B-72 acrylic resin, gelatin and parchment sizes, cyanoacrylates, and suspensions of cellulose fibers. The availability of tips of different sizes, shapes, and materials provides additional adjustability.

The versatility of the equipment suggests its application in a variety of traditional and non-traditional conservation treatment applications. For paper and membrane repair operations (fig. 6), fluid dispensing equipment has given a significant degree of precision to traditional edge repairs, fiber bridge mends, micro pulp fills with fiber suspensions, as well as the use of methods particularly suited to the equipment such as the micro-dot "welding" of tears. Consolidation of several different types of flaking media has also been performed, as well as some types of leather repair using solvent/modified cellulose solutions of different viscosities.

In less traditional applications, B-72 acrylic resin in acetone has been used to remount or repair a number of paper-collared plaster casts in their original location after the animal glue originally used had failed. The use of cyanoacrylates with the fluid dispensing equipment in a number of experimental applications including that of polyester film "welding" has shown interesting results, though a number of concerns still pertain for this application.

REFERENCE

Quandt, A. 1995. Developments in the conservation of parchment manuscripts. *Book and Paper Group Annual* 15: 99–115.

Fig. 6. Application of thicker fluid (wheat starch paste) using flexible tip.

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