

Description

This invention relates generally to ink jet printing and more particularly to nozzle plates for use in constructing thermal ink jet printheads.

In U.S. Patent Number 4,694,308 issued to C. S. Chan et al, there is disclosed and claimed a new and improved nickel barrier layer and nozzle plate assembly for use in thermal ink jet printheads. In this patent, there is described a composite nozzle plate with a nickel barrier layer portion and an outer nickel orifice plate portion, and these two portions are integrally formed in a two mask step electroforming process. The nozzle plate thus formed includes convergent orifice passageways which serve to minimize gulping and cavitation wear during an ink jet printing operation.

In U.S. Patent Number 4,675,038 issued to James G. Bearss et al, there is disclosed and claimed a new and improved compound bore fabrication process for improving the orifice center-to-center spacing density in metal nozzle plates without requiring a corresponding reduction in nozzle plate thickness. Both of these commonly assigned patents are assigned to the present assignee and are incorporated herein by reference. Additionally, the actual electroforming process chemistry for plating the layers of nickel described in these two copending applications is described in more detail in the Hewlett-Packard Journal, Volume 38, Number 5, May 1985, also incorporated herein by reference.

The invention described and claimed herein has as its principal object the provision of a new and improved nozzle plate geometry characterized by an improved and extended frequency response.

Another object of this invention is to provide a nozzle plate of the type described which, relative to known prior art nozzle plates, has a higher capillary restoring force, hence higher fluid refill rates and a higher dynamic response.

A further object is to provide a new and improved nozzle plate of the type described which exhibits increased wettability with respect to orifices having smooth interior surfaces.

These and other objects and advantages of this invention are achieved herein by initially forming a mask having serrated or sculptured outer surfaces on the surface of a selected substrate and then electroforming a nozzle plate on the substrate surface and having orifice openings therein with internal surface contours defined by the sculptured surface areas of the mask. Once the nozzle plate is electroformed on the substrate, the substrate may then be removed from the nozzle plate and the mask removed from the orifices in the nozzle plate to thereby leave the nozzle plate having interior sculptured orifices therein.

Figures 1-5 illustrate schematically a sequence of process steps used in fabricating a serrated or sculptured convergent nozzle plate.

Figure 6 is an enlarged fragmented view of the convergent interior sculptured surfaces of the nozzle plate in Fig. 5.

Referring now to Figure 1, there is shown a stainless steel substrate 10 with a surface layer 12 of photoresist thereon. The structure of Figure 1 is taken to a conventional photoresist masking and etching station where a sculptured or grooved surface pattern 14 is etched in a photoresist mask segment 16. This mask segment is only one of a larger number of mask segments (not shown) used to define a corresponding plurality of convergent orifices in an ink jet nozzle plate being manufactured.

The masked structure in Figures 2 and 3 is transferred to an electroforming station of the type described in the above Chan et al U.S. Patent No. 4,694,308 and the above Hewlett-Packard Journal and plated with a layer 18 of nickel with orifices therein having interior grooves 20 which are replicated from the grooves 14 in the mask segments 16. These grooves 20 thus define a serrated or sculptured pattern on the interior surfaces of the convergent orifices of the nozzle plate 18 as shown in Figure 4.

Finally the nozzle plate 18 in Figure 4 is stripped away from the nickel substrate 10, with chemical etchant applied to the photoresist mask 16 as needed, to leave the resultant nozzle plate structure shown in Figure 5.

The serrations or grooves in the interior walls of the orifice bore are seen in greater detail in the enlarged fragmented view of Fig. 6. The center-to-center spacing of these grooves will typically be in the range of 20-25 microns, and the exit diameter 22 of the orifice opening in Figure 6 will be about 130 microns. The pitch of the "teeth" defining and bounding the grooves 20, which is the distance from the inscribed circle with a diameter 22 to the outside edge of each tooth or serration bounding each groove, will be about 15 microns. These grooves serve to increase and optimize the surface area of the orifice bore and thereby increase its capillarity, fluid flow rate, wettability, damping factor and frequency response relative to these parameters for a smooth surface orifice bore.

Various modifications may be made in the above described embodiment without departing from the scope of this invention. For example, the present invention may be incorporated in either the composite nickel barrier layer process of the above-identified Chan et al patent or the compound bore process of the above identified Bearss et al patent. In addition, the present invention is not limited to the formation of an exit orifice with the

circular geometry shown in the above described embodiment. Instead, other geometries such as rectangles and other multiple sided orifice openings may be used in combination with the serrated or sculptured orifice structure described and claimed herein. 5

Claims

1. A nozzle plate (18) for a liquid ejection device, comprising an orifice having an interior wall (20) in the thickness of the plate (18), characterised in that said wall (20) has a grooved surface pattern (22) on its surface. 10
2. A nozzle plate (18) according to Claim 1 wherein the grooved surface pattern comprises a large number of ridges and troughs extending in the direction through the orifice. 15
3. A nozzle plate (18) according to Claims 1 and 2 wherein the orifice is convergent. 20

Patentansprüche

1. Düsenplatte (18) für eine Flüssigkeit auswerfende Vorrichtung mit einer Öffnung, welche eine sich in der Dicke der Platte (18) erstreckende Innenwand (20) aufweist, dadurch gekennzeichnet, daß die Wand (20) ein genutetes Flächenmuster (22) auf ihrer Oberfläche aufweist. 25
2. Düsenplatte (18) nach Anspruch 1, bei dem das genutete Flächenmuster eine große Anzahl von Rippen und Mulden aufweist, die sich in Richtung durch die Öffnung erstrecken. 30
3. Düsenplatte (18) nach Anspruch 1 und 2, bei der die Öffnung konvergent ist. 40

Revendications

1. Plaque à buses (18) pour un dispositif d'éjection de liquide, comprenant un orifice ayant une paroi intérieure (20) pratiquée dans l'épaisseur de la plaque (18), caractérisée en ce que ladite paroi (20) présente un profil de surface rainurée (22) sur sa surface. 45
2. Plaque à buses (18) selon la revendication 1, dans laquelle le profil de surface rainurée comprend un grand nombre de crêtes et de vallées qui s'étendent dans la direction qui traverse l'orifice. 50
3. Plaque à buses (18) selon les revendications 1 et 2, dans laquelle l'orifice est convergent. 55



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2. A nozzle plate (18) according to Claim 1 wherein the grooved surface pattern comprises a large number of ridges and troughs extending in the direction through the orifice.

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3. A nozzle plate (18) according to Claims 1 and 2 wherein the orifice is convergent.

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Patentansprüche

1. Düsenplatte (18) für eine Flüssigkeit auswerfende Vorrichtung mit einer Öffnung, welche eine sich in der Dicke der Platte (18) erstreckende Innenwand (20) aufweist, dadurch gekennzeichnet, daß die Wand (20) ein genutetes Flächenmuster (22) auf ihrer Oberfläche aufweist.

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2. Düsenplatte (18) nach Anspruch 1, bei dem das genutete Flächenmuster eine große Anzahl von Rippen und Mulden aufweist, die sich in Richtung durch die Öffnung erstrecken.

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3. Düsenplatte (18) nach Anspruch 1 und 2, bei der die Öffnung konvergent ist.

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Revendications

1. Plaque à buses (18) pour un dispositif d'éjection de liquide, comprenant un orifice ayant une paroi intérieure (20) pratiquée dans l'épaisseur de la plaque (18), caractérisée en ce que ladite paroi (20) présente un profil de surface rainurée (22) sur sa surface.

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2. Plaque à buses (18) selon la revendication 1, dans laquelle le profil de surface rainurée comprend un grand nombre de crêtes et de vallées qui s'étendent dans la direction qui traverse l'orifice.

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3. Plaque à buses (18) selon les revendications 1 et 2, dans laquelle l'orifice est convergent.