

## METHOD AND APPARATUS FOR LASER IMPULSE SAMPLE DEPOSITION

### BACKGROUND OF INVENTION

[0001] 1. Field of Invention This invention relates to deposition of sample materials using a laser or other illumination beam.

[0002] 2. Description of Related Art

[0003] Manipulation of material samples is important in a variety of fields, such as in automated proteomic, genomic, and other biotech-related research. Commonly, material samples are handled in liquid form using a variety of different types of liquid handling apparatus, such as pipettors, robotically-manipulated liquid handling tools, spotting devices, etc. To improve processing times, sample density or other features, particularly in automated research operations, sample sizes have been made progressively smaller and smaller. In some case, standard liquid handling apparatus, such as hand-held pipettors, are not suitable for manipulating small sample volumes, such as nanoliter-sized samples.

### SUMMARY OF INVENTION

[0004] In one aspect of the invention, a sample may be deposited on a work surface based on an illumination beam being incident on a sample transfer device. For example, a liquid material may be positioned on or near a sample transfer device, and when the sample transfer device is illuminated by an illumination beam, at least a portion of the sample material may be transferred to a work surface. By controlling the deposition of samples based on an illumination beam, the size and/or position of the deposited sample on the work surface may be closely controlled.

[0005] In one aspect of the invention, a sample depositing system includes an illumination source that forms an illumination beam. For example, the illumination source may be or include a laser, such as a YAG laser. A sample transfer device may carry a sample material to be deposited on a work surface. The sample transfer device may include at least one layer of a material that is relatively transparent to the illumination beam, such as quartz, another inorganic material or other plastic material. The sample transfer device may also include a layer of opaque or transmission-resistant material, such as a layer of nickel or aluminum, a plastic material such as mylar, or other material. Illumination of a portion of the sample transfer device by the illumination beam may cause a portion of the sample material carried by the sample transfer device to be separated from the sample transfer device and deposited on a work surface. The mechanism by which the portion of sample material is separated from the sample transfer device may vary in different ways. For example, in one aspect of the invention, illumination of the sample transfer device by the illumination beam may cause uneven heating and/or expansion in portions of the sample transfer device. This uneven heating/expansion can cause the sample transfer device to buckle or otherwise move rapidly, releasing a portion of the sample carried by the sample transfer device. However, sample deposition does not result from the separation of a portion of the sample transfer device adjacent the sample material that carries sample material with it.

[0006] In another aspect of the invention, illumination of the sample transfer device can cause localized heating of a

portion of the sample transfer device and/or the sample material. This localized heating may cause a rapid expansion, e.g., caused by vaporization of a portion of the sample transfer device and/or the sample material. This rapid expansion may cause a portion of the sample material to be separated from the sample transfer device and deposited on a work surface.

[0007] In another aspect of the invention, illumination of the sample transfer device and/or the sample material may transfer kinetic or other energy from the illumination beam to a portion of the sample material, causing the portion of sample material to be separated from the sample transfer device. For example, the illumination beam may cause bonds in the sample material and/or between the sample material and the sample transfer device to be broken and release energy, thereby causing deposition of a portion of the sample material.

[0008] In one aspect of the invention, a sample depositing system includes an illumination source that forms an illumination beam, and a sample transfer device that receives the illumination beam from the illumination source. A sample material may be carried by the sample transfer device, and a controller may cause the illumination source to illuminate the sample transfer device and thereby cause at least a portion of the sample material carried by the sample transfer device to be controllably separated from the transfer device and deposited on a work surface. The portion of sample material may be deposited without requiring a portion of the sample transfer device positioned adjacent the sample material to separate from the sample transfer device.

[0009] In another aspect of the invention, a method for depositing a sample material includes providing a sample material on a sample transfer device, and illuminating the sample transfer device with an illumination beam. At least a portion of the sample material may be caused to be separated from the sample transfer device and deposited on a work surface in response to illumination of the illumination beam. The portion of the sample material may be deposited without requiring a portion of the surface positioned adjacent the sample material to separate from the sample transfer device.

[0010] These and other aspects of the invention will be apparent and/or obvious from the following detailed description and appended claims.

### BRIEF DESCRIPTION OF DRAWINGS

[0011] Aspects of the invention are described in connection with the following illustrative drawings in which like numerals reference like elements, and wherein:

[0012] **FIG. 1** is a sample deposition apparatus in accordance with one aspect of the invention;

[0013] **FIG. 2** shows a side view of a first embodiment of a sample transfer device emitting a sample droplet;

[0014] **FIG. 3** shows a side view of another illustrative embodiment of a sample transfer device emitting a sample droplet;

[0015] **FIG. 4** shows a side view of another illustrative embodiment of a sample transfer device having a projection extending into a sample material;

[0016] **FIG. 5** shows a side view of yet another embodiment of a sample transfer device having a nozzle-like cavity;