THE ARTISTIC APPLICATIONS OF M.E.M.S.: *GALLERY ON A CHIP*

Kathryn Ecsedy, Ian Harvey Ph.D.

nanofab University of Utah

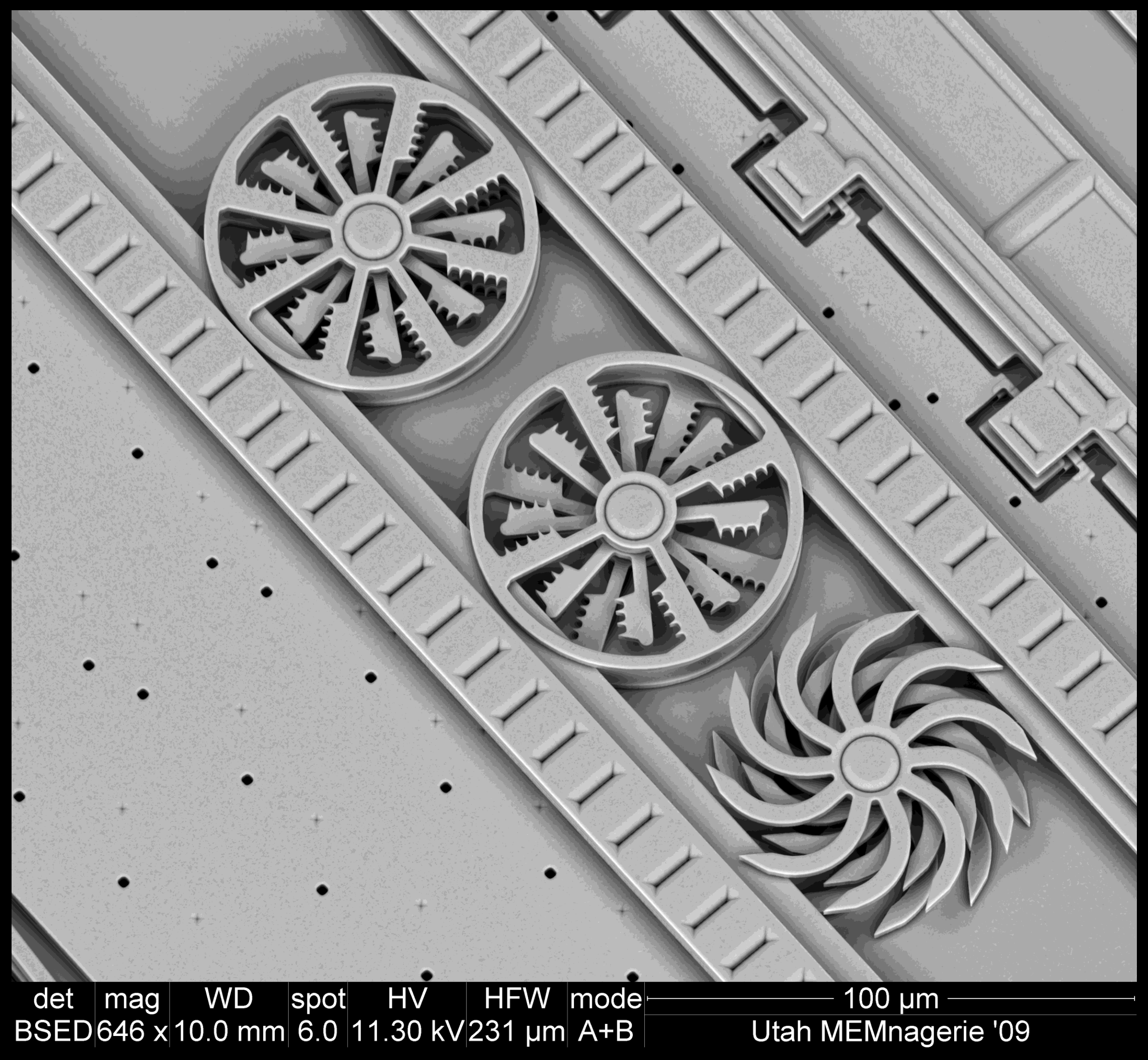
CIDAT

THE UNIVERSITY OF UTAH

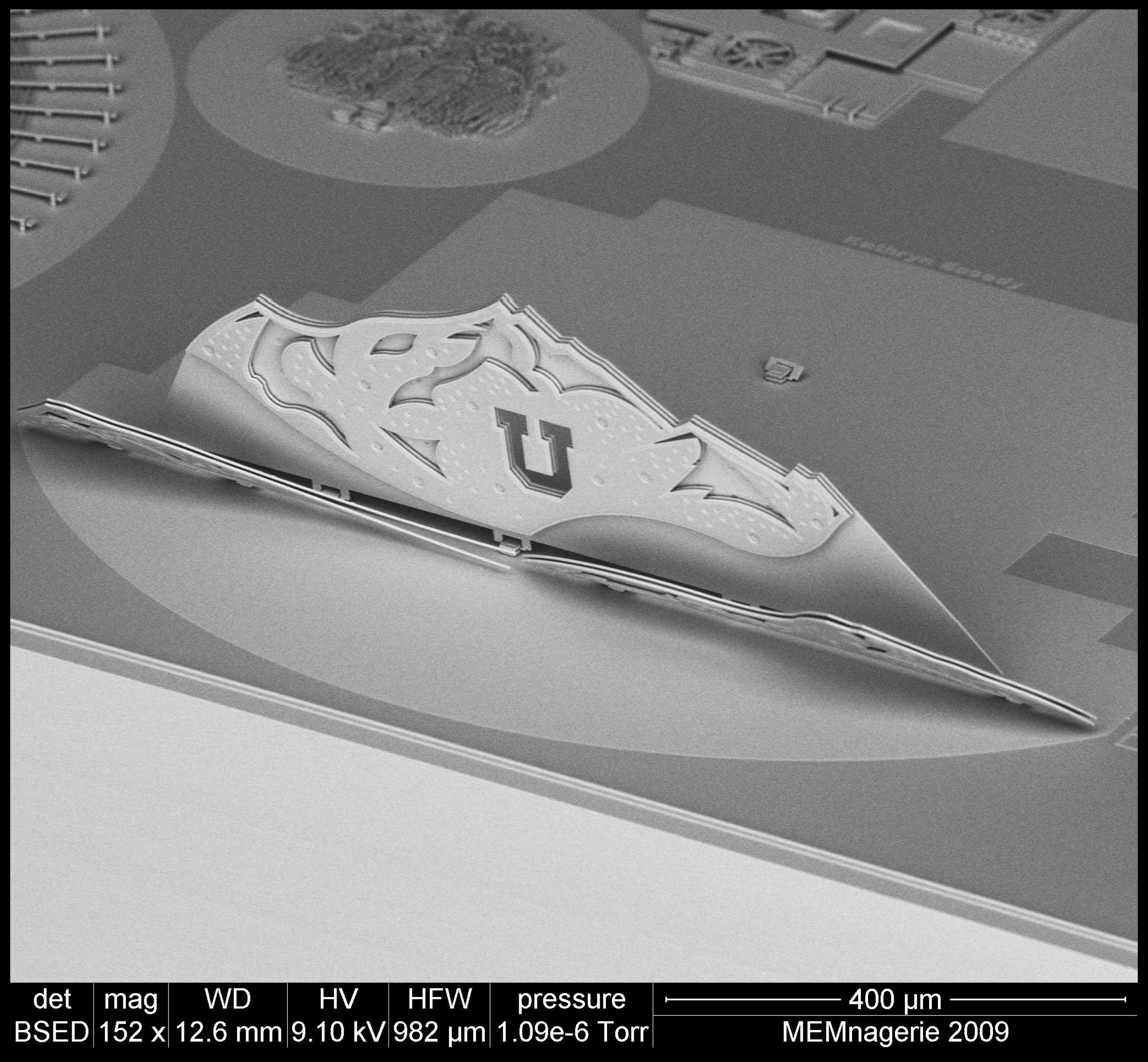
Sandia National Laboratories

µCHARGE PUMP ACTUATION

Micro charge pump actuation, or µCPA, is an electrical phenomenon harnessed to power these MEMS devices. µCPA is a result of basic electrical properties: charge differential will cause objects to attract or repel. Within a scanning electron microscope (SEM), negatively charged electrons are shot at a sample to get an image. The various layers in a MEMS device will charge at different rates and, because of attractive or repulsive force, will be attracted to or repelled from other layers on the microchip. When struck by the microscope's electrons the devices move unattached to any wires or outside source. Essentially, the device is powered simply by viewing it. It requires careful manipulation of the SEM to achieve just the right energy to accurately charge these devices; too little or too much will disturb the delicate charge balance.



SEM image of the un-deployed disks from *The Pinball Machine,* built by Kurtis Ford for the 2009 MEMnagerie design.



SEM image of *Micromountains,* a work built by Kathryn Ecsedy for the 2009 MEMnagerie design.

ABSTRACT

Our research explored the crossroads between art and science to create tiny devices known as MEMS (Micro Electrical Mechanical Systems). These artistic devices are powered by micro charge-pumped actuation of electrons in a scanning electron microscope, utilizing a phenomenon once considered an irritation as a power source. The pioneering artistic application of this micro-technology has inspired our new genre, "kinetic micro sculpture".

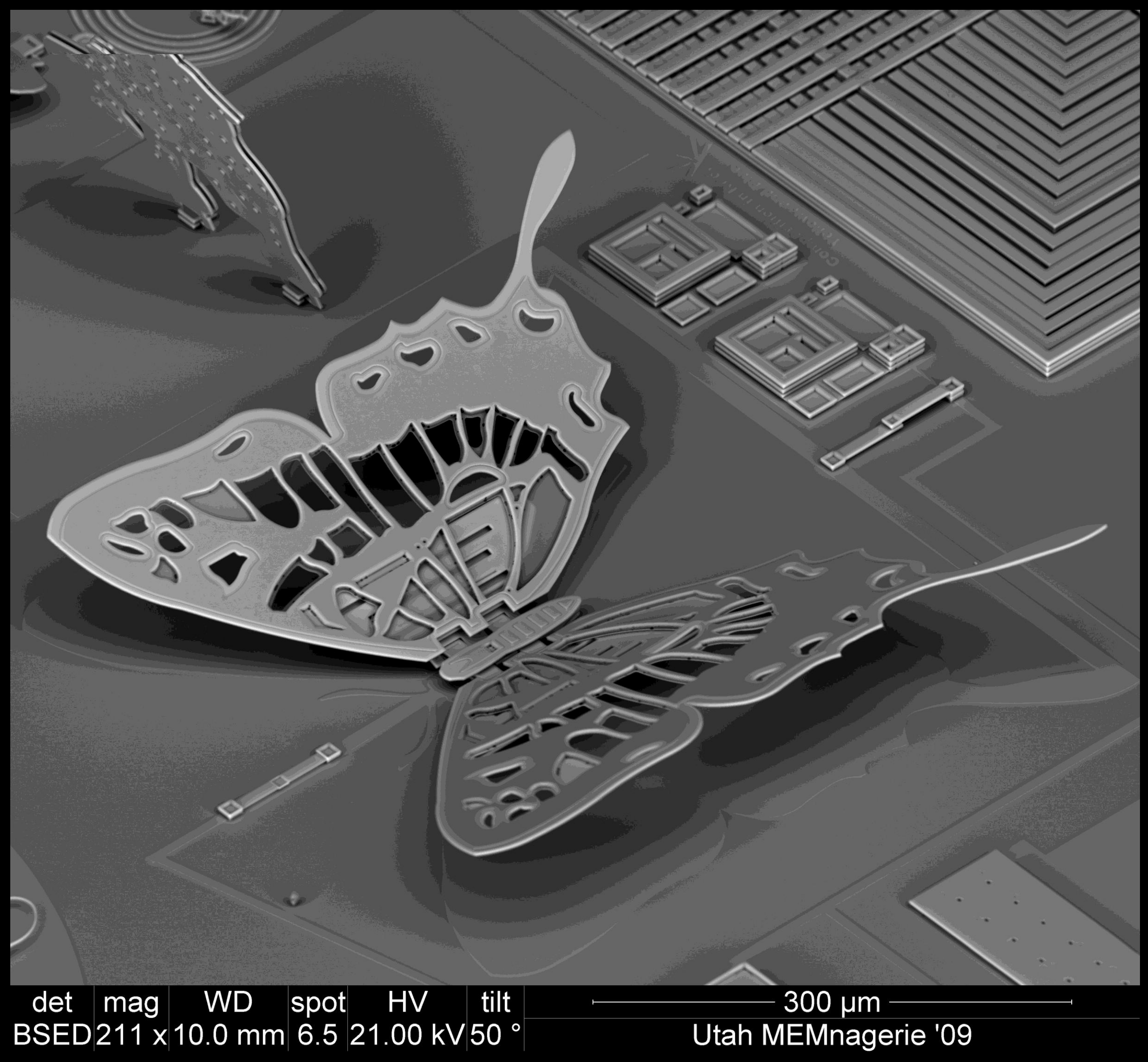
These kinetic works move in a variety of ways, such as spontaneous out of plane motion, and demonstrate a broad range of artistic methods. Using polysilicon as a medium, we have made use of such techniques as stippling, shading, negative space, and point of view. When manufacturing MEMS, small punctures known as "etch release holes" are a crucial necessity for the acid baths of production. We took advantage of this requirement, using the holes after the manner of stippling or pointillism to create shadow. A similar process was to use cuts of different depths to create shading; depending on how many layers of polysilicon were left determined the darkness or brightness of that area. To increase brightness further, some works were coated in bright aluminum. These are only a few examples of the many possibilities for artistic expression on the micro scale. It is in effect, a gallery on a chip.

WHAT ARE MEMS?

MEMS is an abbreviation of Micro Electrical Mechanical System. These micro scale devices are commonly used for a variety of applications such as actuators and sensors.

To make a MEMs device several layers of polysilicon are deposited one at a time. Each individual layer is covered with pattern, or "mask", and then dipped into an acid bath which removes all but the desired material. Several "sacrificial layers" are also used to keep the layers independent from each other where desired.

The red rectangle within the white is the actual size of an entire microchip. A single chip may contain dozens of MEMS.



SEM image of *The Butterfly,* a work built by Kurtis Ford and Paul Stout for the 2009 MEMnagerie design.

THE ARTISTIC APPLICATIONS OF M.E.M.S.: *GALLERY ON A CHIP*

Kathryn Ecsedy, Ian Harvey Ph.D.

nanofab
University of Utah

CIDAT

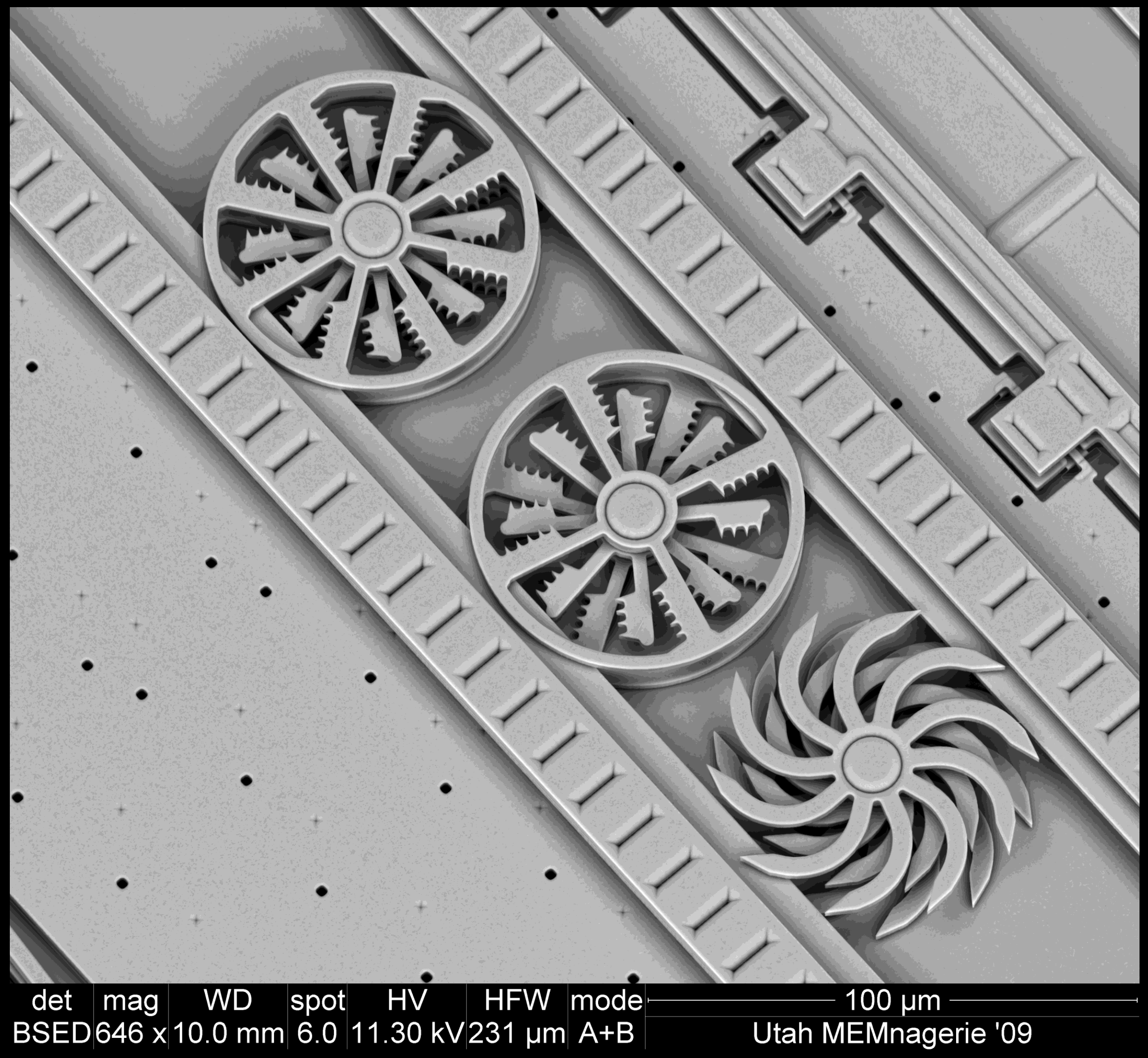
THE UNIVERSITY OF UTAH

Sandia National Laboratories

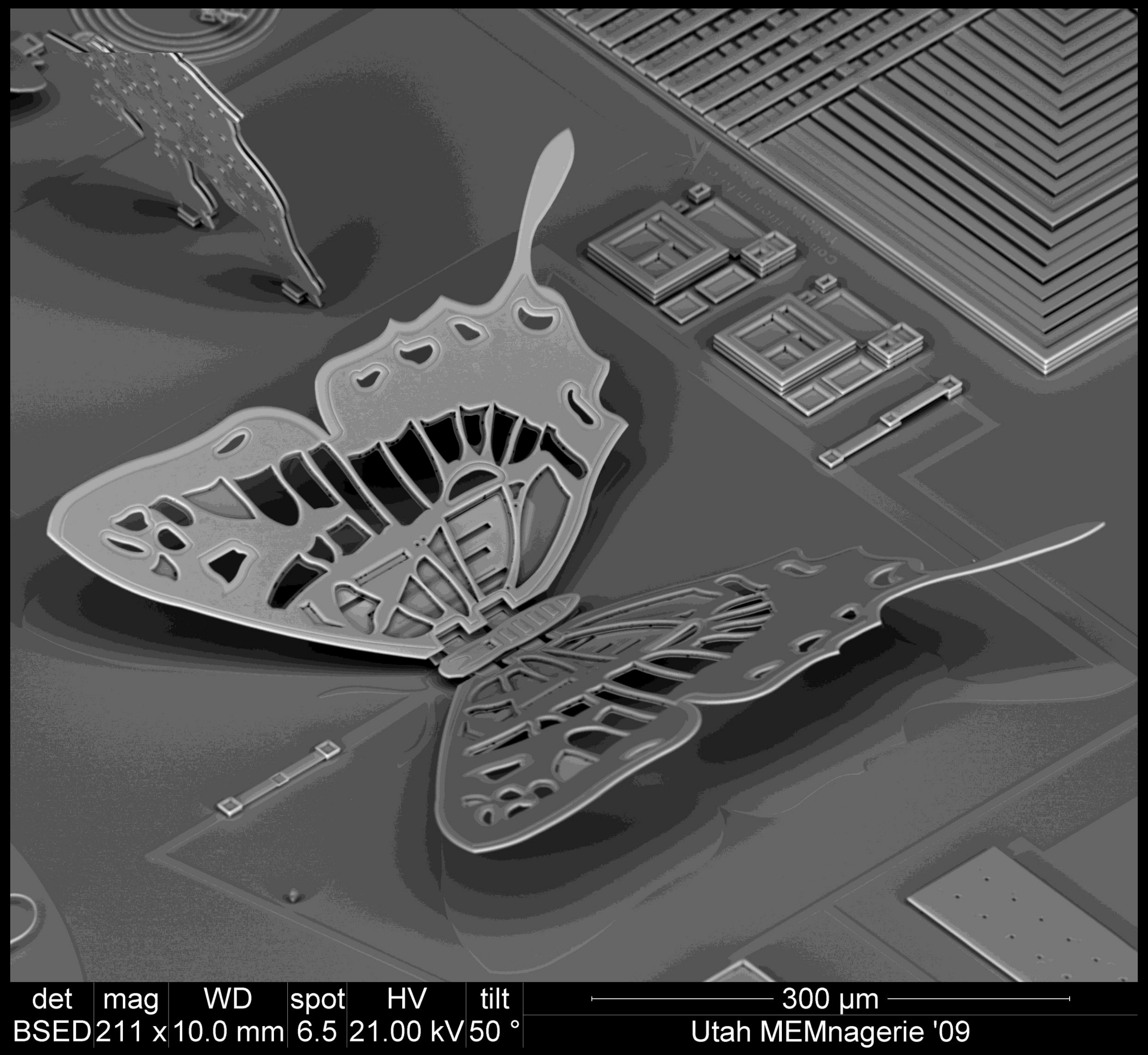
ABSTRACT

Our research explored the crossroads between art and science to create tiny devices known as MEMS (Micro Electrical Mechanical Systems). These artistic devices are powered by micro charge-pumped actuation of electrons in a scanning electron microscope, utilizing a phenomenon once considered an irritation as a power source. The pioneering artistic application of this micro-technology has inspired our new genre, "kinetic micro sculpture".

These kinetic works move in a variety of ways, such as spontaneous out of plane motion, and demonstrate a broad range of artistic methods. Using polysilicon as a medium, we have made use of such techniques as stippling, shading, negative space, and point of view. When manufacturing MEMS, small punctures known as "etch release holes" are a crucial necessity for the acid baths of production. We took advantage of this requirement, using the holes after the manner of stippling or pointillism to create shadow. A similar process was to use cuts of different depths to create shading; depending on how many layers of polysilicon were left determined the darkness or brightness of that area. To increase brightness further, some works were coated in bright aluminum. These are only a few examples of the many possibilities for artistic expression on the micro scale. It is in effect, a gallery on a chip.



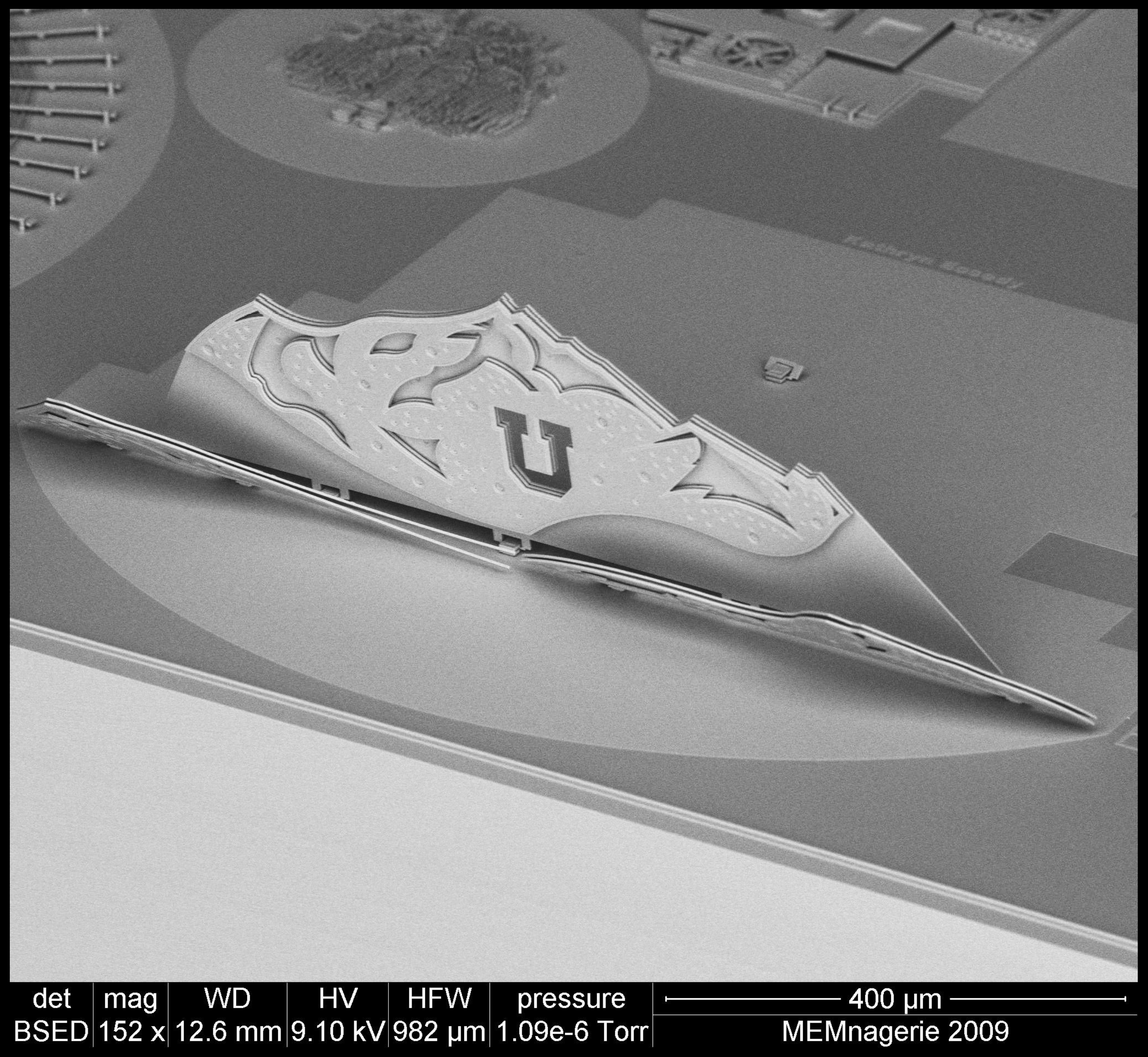
SEM image of the un-deployed disks from *The Pinball Machine,* built by Kurtis Ford for the 2009 MEMnagerie design.



SEM image of *The Butterfly,* a work built by Kurtis Ford and Paul Stout for the 2009 MEMnagerie design.

µCHARGE PUMP ACTUATION

Micro charge pump actuation, or µCPA, is an electrical phenomenon harnessed to power these MEMS devices. µCPA is a result of basic electrical properties: charge differential will cause objects to attract or repel. Within a scanning electron microscope (SEM), negatively charged electrons are shot at a sample to get an image. The various layers in a MEMS device will charge at different rates and, because of attractive or repulsive force, will be attracted to or repelled from other layers on the microchip. When struck by the microscope's electrons the devices move unattached to any wires or outside source. Essentially, the device is powered simply by viewing it. It requires careful manipulation of the SEM to achieve just the right energy to accurately charge these devices; too little or too much will disturb the delicate charge balance.



SEM image of *Micromountains,* a work built by Kathryn Ecsedy for the 2009 MEMnagerie design.

WHAT ARE MEMS?

MEMS is an abbreviation of Micro Electrical Mechanical System. These micro scale devices are commonly used for a variety of applications such as actuators and sensors.

To make a MEMs device several layers of polysilicon are deposited one at a time. Each individual layer is covered with pattern, or "mask", and then dipped into an acid bath which removes all but the desired material. Several "sacrificial layers" are also used to keep the layers independent from each other where desired.

The red rectangle within the white is the actual size of an entire microchip. A single chip may contain dozens of MEMS.