What is claimed is:

1. A method of forming a magnetic recording substrate, comprising:

modifying a magnetic property of a portion of a magnetically active layer of the magnetic recording medium by focusing patterned energy on an exposure zone of the substrate, wherein the patterned energy is selected to modify the magnetic properties without substantially modifying the shape of the substrate surface.

2. The method of claim 1, wherein the patterned energy comprises deep UV laser energy divided by a diffraction grating, or a plurality of laser beams emitted by an array of laser emitters, or a plurality of electron beams emitted by an array of electron emitters, or a plurality of ion beams emitted by an array of ion emitters.

3. The method of claim 1, wherein the entire surface of a substrate is treated by sequentially treating a plurality of exposure zones identified on the substrate surface.

4. The method of claim 1, wherein a plurality of substrates is treated by positioning the substrates on a substrate carrier, identifying a plurality of exposure zones across all substrates positioned on the substrate carrier, and sequentially treating all the exposure zones.

5. The method of claim 1, wherein the patterned energy is carried by energy carriers having energy density between about 10 mJ/cm^2 and about 500 mJ/cm^2.

6. The method of claim 1, wherein the magnetically active layer has an amorphous structure, and modifying the magnetic properties of portions of the magnetically active layer comprises crystallizing the portions into magnetically susceptible domains by exposure to the patterned energy or reducing magnetic susceptibility of the portions by exciting thermal motion of atoms in the portions.

7. The method of claim 6, wherein a dimension of the magnetically susceptible domains is controlled by adjusting duration of exposure to the patterned energy, intensity of the patterned energy, and ambient temperature of the substrate.

8. An apparatus for modifying a magnetic property of a substrate, comprising:

a work surface;

a source of directed energy facing the work surface;

a patterning divider disposed between the energy source and the work surface; and

a rectifier disposed between the patterning member and the work surface.

9. The apparatus of claim 8, wherein the energy source is a deep-UV laser, the patterning divider is a diffraction grating, and the rectifier is an optical lens, or the energy source is an e-beam, the patterning divider is a thin film single crystal, and the rectifier is an electrostatic lens, or the energy source is an ion generator, the patterning divider is a perforated plate, and the rectifier is an electrostatic column.

10. The apparatus of claim 8, further comprising an aperture disposed between the rectifier and the work surface.

11. An apparatus for modifying the magnetic properties of a substrate, comprising:

an energy source for producing laser, e-beam, or focused ion energy carriers with average energy density between about 10 mJ/cm^2 and about 500 mJ/cm^2;

a work surface facing the energy source, wherein at least one of the work surface and the energy source is moveable in one or more directions under the control of one or more controllers and one or more positioners coupled to the work surface, the energy source, or both;

a divider disposed between the energy source and the work surface, the divider having a plurality of substantially identical apertures spaced in a regular pattern and shaped to transform incident energy from the energy source into a plurality of substantially identical beamlets; and

a rectifier disposed between the divider and the work surface, the rectifier configured to focus and direct the beamlets toward the work surface in a pattern having a desired dimension and distribution.

12. The apparatus of claim 11, further comprising an aperture disposed between the rectifier and the work surface, the aperture being shaped to produce the desired pattern of beamlets.

13. A device having a magnetically active layer, wherein the magnetically active layer comprises amorphous and crystalline domains, the crystalline domains have identifiably different magnetic properties from the amorphous domains, and the crystalline domains have an average dimension along the surface of the magnetically active layer of not more than about 50 nm.

14. The device of claim 13, wherein the crystalline domains are polycrystalline.

15. The device of claim 13, wherein the crystalline domains are separated by an average distance not more than about 50 nm.

AMENDED CLAIMS
received by the International Bureau on 17 December 2010 (17.12.2010)

1. A method of forming a magnetic recording medium, comprising:

modifying a magnetic property of a surface portion of a magnetically active layer of the magnetic recording medium by focusing patterned energy on the surface portion, wherein the patterned energy is selected to modify the magnetic properties without substantially modifying the shape of the surface portion.

2. The method of claim 1, wherein the patterned energy comprises deep UV laser energy divided by a diffraction grating, or a plurality of laser beams emitted by an array of laser emitters, or a plurality of electron beams emitted by an array of electron emitters, or a plurality of ion beams emitted by an array of ion emitters.

3. The method of claim 1, wherein the entire surface of a substrate is treated by sequentially treating a plurality of exposure zones identified on the substrate surface.

4. The method of claim 1, wherein a plurality of substrates is treated by positioning the substrates on a substrate carrier, identifying a plurality of exposure zones across all substrates positioned on the substrate carrier, and sequentially treating all the exposure zones.

5. The method of claim 1, wherein the patterned energy is carried by energy carriers having energy density between about 10 mJ/cm^2 and about 500 mJ/cm^2.

6. The method of claim 1, wherein the magnetically active layer has an amorphous structure, and modifying the magnetic properties of the surface portions of the magnetically active layer comprises crystallizing the surface portions into magnetically susceptible domains by exposure to the patterned energy or reducing magnetic susceptibility of the surface portions by exciting thermal motion of atoms in the surface portions.

7. The method of claim 6, wherein a dimension of the magnetically susceptible domains is controlled by adjusting duration of exposure to the patterned energy, intensity of the patterned energy, and ambient temperature of the substrate.

AMENDED SHEET (ARTICLE 19)

8. An apparatus for modifying a magnetic property of a substrate, comprising:

a work surface;

a source of directed energy facing the work surface;

a patterning divider disposed between the energy source and the work surface; and

a rectifier disposed between the patterning member and the work surface.

9. The apparatus of claim 8, wherein the energy source is a deep-UV laser, the patterning divider is a diffraction grating, and the rectifier is an optical lens, or the energy source is an e-beam, the patterning divider is a thin film single crystal, and the rectifier is an electrostatic lens, or the energy source is an ion generator, the patterning divider is a perforated plate, and the rectifier is an electrostatic column.

10. The apparatus of claim 8, further comprising an aperture disposed between the rectifier and the work surface.

11. An apparatus for modifying the magnetic properties of a substrate, comprising:

an energy source for producing laser, e-beam, or focused ion energy carriers with average energy density between about 10 mJ/cm^2 and about 500 mJ/cm^2;

a work surface facing the energy source, wherein at least one of the work surface and the energy source is moveable in one or more directions under the control of one or more controllers and one or more positioners coupled to the work surface, the energy source, or both;

a divider disposed between the energy source and the work surface, the divider having a plurality of substantially identical apertures spaced in a regular pattern and shaped to transform incident energy from the energy source into a plurality of substantially identical beamlets; and

a rectifier disposed between the divider and the work surface, the rectifier configured to focus and direct the beamlets toward the work surface in a pattern having a desired dimension and distribution.

12. The apparatus of claim 11, further comprising an aperture disposed between the rectifier and the work surface, the aperture being shaped to produce the desired pattern of beamlets.

13. A device having a magnetically active layer, wherein the magnetically active layer comprises amorphous and crystalline domains, the crystalline domains have identifiably different magnetic properties from the amorphous domains, and the crystalline domains have an average dimension along the surface of the magnetically active layer of not more than about 50 nm.

14. The device of claim 13, wherein the crystalline domains are polycrystalline.

15. The device of claim 13, wherein the crystalline domains are separated by an average distance not more than about 50 nm.

What is claimed is:

1. An apparatus for modifying a magnetic property of a substrate, comprising:
a work surface;
a source of directed energy facing the work surface;
a patterning divider disposed between the energy source and the work surface; and
a rectifier disposed between the divider and the work surface.

2. The apparatus of claim 1, wherein the energy source is a laser, the patterning divider is a diffraction grating, and the rectifier is an optical lens.

3. The apparatus of claim 1, wherein the energy source is an e-beam, the patterning divider is a thin film single crystal, and the rectifier is an electrostatic lens.

4. The apparatus of claim 1, wherein the energy source is an ion generator, the patterning divider is a perforated plate, and the rectifier is an electrostatic column.

5. The apparatus of claim 1, further comprising an aperture disposed between the rectifier and the work surface.

6. The apparatus of claim 1, wherein the work surface is movable in at least one dimension under the control of a controller.

7. The apparatus of claim 2, wherein the laser operates at a wavelength of about 300 nm or shorter.

8. An apparatus for modifying the magnetic properties of a substrate, comprising:

an energy source for producing laser, e-beam, or focused ion energy carriers with average energy density between about 10 mJ/cm^2 and about 500 mJ/cm^2;

a work surface facing the energy source, wherein at least one of the work surface and the energy source is moveable in one or more directions under the control of one or more controllers and one or more positioners coupled to the work surface, the energy source, or both;

a divider disposed between the energy source and the work surface, the divider having a plurality of substantially identical apertures spaced in a regular pattern and shaped to transform incident energy from the energy source into a plurality of substantially identical beamlets; and

a rectifier disposed between the divider and the work surface, the rectifier configured to focus and direct the beamlets toward the work surface in a pattern having a desired dimension and distribution.

9. The apparatus of claim 8, further comprising an aperture disposed between the rectifier and the work surface, the aperture being shaped to produce the desired pattern of beamlets.