

deposition source including, for example, a sputtering source. In another embodiment, the source 311 is a chemical vapor deposition source including, for example, a direct ion source using a hydrocarbon precursor gas. Beam 312 is focused on a location 319 on the substrate 309 whereat the material of the beam 312 is deposited to form a film of an energy-storage device. An assist source 313 is provided in the chamber 307 and produces a beam of energized particles 314 directed at least adjacent to the location 319 on the substrate 309. In some embodiments, the assist source is an energized ion-producing source. In some embodiment, the assist source 313 is offset from the first source 311 such that the beams from these sources are not coincident. The energized particle beam 314 provides the energy that is required to control the growth and stoichiometry of the material in the first beam 312 into a crystalline structure on the substrate 309 as is explained in greater detail herein. In one embodiment, the energized particle beam 314 also provides elements that are required in the film being deposited. In another embodiment, beam 314 is directed at least near location 319 such that sufficient energy to form the desired crystal structure and stoichiometry of the film being deposited is supplied by beam 314 to the material in first beam 312. In some embodiments, the deposition system 305 includes at least one additional assist source 313A. In some embodiments, each of the sources 313A provides an additional assist beam 314A that provides energy to arriving adatoms at the substrate. Various embodiments of assist beams 314 are described below.

[0156] FIG. 3B shows another embodiment of a deposition apparatus 305. The assist source 313 produces an energy beam 314 that travels along a path that is essentially normal to the substrate 319. The source of material to be deposited 311 is offset from assist source 313. In some embodiments, source 311 produces a beam of adatoms 312 that travels along a path that is non-normal to the substrate 319. The energy beam supplies energy to the adatoms from beam 312 as described herein.

[0157] FIG. 4 is a view substantially similar to FIG. 3A, except that depositing apparatus 405 includes an assist source 413 for producing the energized beam that is pivotally mounted to a bracket fixed in the chamber 307. The assist source 413 pivots to direct the energized particle beam 414 at a desired impingement angle to the surface of the substrate 309. In an embodiment, the impingement angle is in the range of about 15 degrees to about 70 degrees from normal to the substrate. Accordingly, in some embodiments, the impingement angle is variable. In one embodiment, the impingement angle is about 45 degrees. In some embodiments, the deposition system 405 includes at least one additional assist source 413A. In some embodiments, each of the sources 413A provides an additional assist beam 414A that provides energy to arriving adatoms at the substrate. In some embodiments, the energy provided by assist beam 414 differs from the energy provided by at least one of assist beams 414A. In some embodiments, the assist beam 414 and 414A need not simultaneously transmit energy to the adatoms. In some embodiments, the means by which the beams 414 and 414A transmit energy are different. In some embodiments, the material in beams 414 and 414A are different.

[0158] FIG. 5A is a view substantially similar to FIG. 3 except that depositing apparatus 505 includes a plurality of

first deposition sources 511. In one embodiment, each one of the first deposition sources 511 directs its respective beam 512 to the location 319 on the substrate 309. In some embodiments, every one of the first sources 511 produces a beam 512 including the same material. In other embodiments, at least of the first sources 511 produces a beam 512 of a material that is different than that of another of the first sources 511. In some embodiments, the materials from the plurality of first beams 512 combine at the location 319 to form the desired film. In other embodiments, the materials in first beams 512 combine with material from assist beam 314 to form the desired film. In one embodiment, one of the first sources 511 directs its beam 512 to the substrate 319 but away from the location 319. In some embodiments, a plurality of assist sources 313 provide energy to the adatoms of beams 512.

[0159] FIG. 5B shows another embodiment of a depositing apparatus 505B. A plurality of assist sources 313 is positioned to provide energy to a forming film at the substrate 319. A plurality of material sources 511A, 511B, and 511C supply material to the chamber 307 and adjacent the surface of the substrate 319. In some embodiments, each of the material sources 511A, 511B, and 511C provide a same material and, thus, have the ability to provide a greater quantity than one of the sources alone. In some embodiments, at least one of the material sources 511A, 511B, and 511C provides a material different than another of the material sources. In some embodiments, these different materials react at the in chamber 307 to create the adatom material that will form a film on the substrate 319. In some embodiments, at least one of the material sources 511A, 511B, and 511C provides a precursor material into chamber 307 and another of the material sources provides a reactant material into the chamber. The precursor and reactant material react together to create the material that will form the film. In some embodiments, at least one of the material sources 511A, 511B, and 511C includes a chemical reactor in which chemicals react. This source then injects the resultant material into the chamber. The resultant material is included in the film fabrication process.

[0160] FIG. 6 is a view substantially similar to FIG. 5A except that depositing apparatus 605 includes a plurality of first deposition sources 511 and a pivotable assist source 413. In some embodiments, this provides more material to a given deposition location. In some embodiments, this provides deposition at multiple locations. In still other embodiments, this allows different materials from different sources to be combined.

[0161] FIG. 7 shows another embodiment of a depositing apparatus 705 according to the teachings of the present invention. Depositing apparatus 705 includes a reaction chamber 707 in which is positioned an elongate, flexible substrate 709 on which an energy-storage device is to be fabricated. The substrate 709 is fed from a source roll 710 over an arched thermal control surface 715 and taken up by an end roll 713. A first material source 711 is provided in the chamber 707 and is a physical deposition source. First source 711 produces a beam of adatoms 712 of a material to be deposited on the substrate 709. In one embodiment, the first source 711 is an arc source including, for example, a cathodic arc source, an anodic arc source, and a CAVAD arc source. In another embodiment, the first source 711 is a physical vapor deposition source including, for example, a