form the ions is used to control the stoichiometry of the growing electrolyte film. For example, an ionized assist beam of O_2 is used to control the growth and stoichiometry of a lithium phosphorus oxynitride material. In another embodiment, an ionized assist beam of N_2 is used. In this embodiment, the N_2 not only controls growth and stoichiometry of the electrolyte film, but also injects additional nitrogen into the electrolyte film. This is desirable due to the ionic transportivity of a LiPON electrolyte film is dependant on the amount of nitrogen in the film.

[0150] **FIG. 2D** shows one embodiment of a method for fabricating an energy-storage device. Steps **251**, **253**, **257**, **261**, and **263** are substantially similar to the steps described above with reference to **FIG. 2B**. Step **255**C is a step for depositing a cathode film at least partially on the cathode contact film. In an embodiment, the cathode film is deposited as described above with reference to **FIG. 2B**. In other embodiments, the cathode film is deposited according to other deposition processes known in the art. Step **259**D is a step for depositing an electrode material to a location at least partially on the electrolyte film, while simultaneously supplying energized particles to the electrode material. In one embodiment, the energized particles are directed to the same location as the electrode material. In an embodiment, the energized particles are energized ions. The energized ions, in an embodiment, include a second material that is different than the first material. The energized particles or the ion beam assist in controlling growth of the structure of the electrode material. Step **259**D, in some embodiments, is used to form an anode film for a solid-state thin-film battery. The anode film is in electrical and physical contact with the anode contact and electrolyte films.

[0151] The deposition of the anode film includes directing an electrode material to a location at least partially in contact with the electrolyte film, while simultaneously supplying energized particles of a second material. The energized particles supply energy to the electrode material to assist in the growth of a desirable crystal structure in the anode film. Moreover, this controls the stoichiometry of the growing film. In one embodiment, the electrode material includes a lithium-intercalation material used as a battery anode. In an embodiment, the anode includes is a lithium metal or a lithium alloy. In another embodiment, the anode includes a carbonaceous material, such as graphite or diamond-like carbon. In another embodiment, the anode includes a metal oxide, for example, RuO or VaO. In another embodiment, the anode includes a nitride material. A secondary source provides particles, which are ions in some embodiments, that provide energy in a range of about 5 eV to about 3000 eV to the lithium-intercalation material. Control of the energy in the ions produced by the secondary source provides in situ control for growing a lithium-intercalation crystalline structure at the location. The energy from the ions assists the formation of lithium-intercalation materials into a crystalline structure at the time of deposition. In one embodiment, the gas used to form the ions is used to control the stoichiometry of the growing, crystalline film.

[0152] The crystalline structure of an electrode thin film formed according to the teachings herein has a higher order than those achieved by conventional film forming techniques. Conventional techniques rely on a high-temperature, post-deposition anneal that affects the substrate and other layers as well as the film intended to reorder and crystallize the structure of that film. In contrast, the present invention provides a controlled energy source at the time of deposition or after the time of deposition that reorders the surface of the deposition film without substantially heating the underlying layers or substrate. In some embodiments, the energy is provided while depositing each atomic layer of a film such that each atomic layer is ordered as crystallizes into the film. Examples of such energy sources include an ion beam that either react with the adatoms being deposited and/or provide kinetic energy to assist in deposition of the film. Other examples of energy sources include high temperature, short duration heat sources, short duration plasma sources, lasers, other high intensity photo sources that reorder the crystal structure adjacent the surface of the film without effecting other layers or the substrate. A highly ordered crystalline cathode or anode is desirably achieved according to the teachings described herein.

[0153] While the above fabrication process describes forming cathode and anode films in a certain order, other embodiments reverse the order of the cathode film and anode film. Moreover, the fabrication process describes forming cathode and anode films, for example in a battery. In some embodiments, the cathode and anode films are electrodes of a battery. Other embodiments include films forming various layers of supercapacitors. Supercapacitors operate In these embodiments, at least one of the films forming the supercapacitor, e.g., electrode films **71**, **75** and electrolyte and/or dielectric film **73**, have improved crystalline structure, crystallite size, or fewer defects without resorting to a high temperature anneal of the entire structure to provide these properties. Accordingly, techniques and systems for fabricating thin films for use in an energy-storage device as described herein are applicable to both solid-state batteries and solid-state capacitors.

[0154] In another embodiment, the thin-film energy-storage device is formed on a substrate. A contact film, which is electrically conductive and does not react with a subsequently deposited, adjacent cathode film, is formed on the substrate. The contact film acts as a barrier between the substrate and the cathode film. The contact film further acts as a current collector and as a connection between the cathode film and circuits that are external to the energy-storage device. In an embodiment, the contact film has a thickness of greater than 0.3 microns.

[0155] **FIG. 3A** shows a deposition apparatus **305** including a reaction chamber **307** in which is positioned a substrate **309** on which an energy-storage device is to be fabricated. Reaction chamber **307**, in one embodiment, is a sealed chamber that holds gases for the reaction and that provides a sub-atmospheric pressure. In some embodiments, it is desirable to hold the pressure in the chamber less than about 1×10^{-3} Torr. A first material source **311** is provided in the chamber **307**. The first source **311** produces a beam of adatoms **312** of a first material to be deposited on the substrate **309**. In one embodiment, the first material source **311** is a physical vapor deposition source. In one such embodiment, the material source **311** is an e-beam source. In another such embodiment, the first source **311** is an arc source including, for example, a cathodic-arc source, an anodic-arc source, and a CAVAD arc source. Arc sources are particularly suited for use as a source as they effectively operate in a chamber that is operated at low temperatures. In another embodiment, the first source **311** is a physical