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An energy and mass selective hyperthermal ion beam for ion-assisted thin film deposition purposes

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In thin film growth using physical vapor deposition methods like e.g. magnetron sputtering, energetic particles are involved in the deposition process acting either directly as film-forming components or indirectly as impinging particles which deliver additional energy and momentum to the surface of the growing film. With most of these techniques, there exists a mixture of all these particle fluxes and they can hardly be separated. An exception is the ion-beam assisted deposition technique, which is characterized by simultaneous irradiation of the growing thin film with energetic ions. By this, a ballistic enhancement of the adatom mobility can be achieved. In the case of nitrogen ion beams however, the typically used nitrogen plasma based ion-beam sources counteract the demand to chose the ion-beam parameters as freely as possible, because the resulting ion beam consists of a blend of both molecular and atomic nitrogen ions. In this contribution, a compact custom setup is presented which allows generating a hyperthermal nitrogen ion beam with variable ion energy and selectable ion mass. This was realized by combining a plasma based ion source with a quadrupole mass filter system, equipped with entry and exit ion optics, ion-beam deflection, as well as ion-beam current monitoring. The key features of this setup are demonstrated and discussed regarding ion-assisted nitride thin film growth using the model system GaN.

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