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Plasma properties during RF magnetron sputtering of lithium phosphorous oxynitride thin films

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Solid-state thin film batteries based on lithium phosphorous oxynitrate (Lipon) are a strong candidate for compact and high power density sources needed for various miniaturized electronic devices [1]. Moreover, inorganic electrolytes exhibit a high decomposition voltage up to 5.5 V against lithium that makes them compatible with high-voltage cathodes. A rechargeable thin film battery needs to show high ionic conductivity for a uniform electrolyte layer of less than 2 µm, to be free of porosity or cracks and not to decompose in contact with the anode. So far, pulsed laser deposition, magnetron sputtering, electron beam evaporation, ion beam assisted deposition and direct vapor deposition have been used to produce Lipon films with different properties at deposition rates below 60 nm/min [2]. Despite of a deposition rate below 3 nm/min thin films by magnetron sputtering shows good electrochemical properties with a strong dependence on N_2 pressure that is not yet well understood. The aim of this work is to correlate the plasma and thin-films properties employing detailed plasma diagnostics by mass spectrometry, optical emission spectroscopy and probes. Experiments are performed in a RF magnetron plasma discharge operated in Ar/N_2 mixtures using a 2 inch cathode with a Li_3PO_4 target provided by Kurt Lesker ®. The influence of RF power, pressure, gas composition and substrate temperature on reactive species formed into plasma and transported on the substrate is investigated in direct correlation with electrochemical properties of the Lipon films deposited on different substrates.

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