MOLECULAR BEAM EPITAXY OF (Al,Sc)N NANOWIRES FOR PIEZOELECTRIC ENERGY HARVESTING

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New types of group III-nitride based transistors and electroacoustic devices are being developed thanks to the successful combination with transition metal nitrides, among which the ternary compound (Al,Sc)N is currently the most attractive candidate. Alloying hexagonal wurtzite AlN with cubic rocksalt ScN can enhance its piezoelectric coefficient by up to a factor of 5, provided that the wurtzite phase is maintained. New opportunities for the combination of these two materials may arise from the growth of (Al,Sc)N nanostructures.

In this work, we grow (Al,Sc)N on self-assembled AlN nanowire stems by molecular beam epitaxy, yielding axial (Al,Sc)N/AlN nanowire heterostructures. Crystalline wurtzite (Al,Sc)N with 15 at.% Sc can be stabilized at moderate growth temperatures of 800 °C, but at the expense of inverse nanowire tapering. Higher substrate temperatures, however, favor the separation into Al-rich wurtzite and Sc-rich rocksalt phases, as evidenced by nanowire branching. Phase-pure wurtzite (Al,Sc)N nanowires are encapsulated in polydimethylsiloxane and processed into vertically integrated nanogenerators and their piezoelectric performance is compared with that of AlN nanowire based reference devices.

The demonstration of (Al,Sc)N nanowires and their encapsulation in a polymer matrix opens new routes for the development of flexible piezoelectric energy harvesters with improved device performance.