NiO thin films growth mechanism using a novel “Electrostatic Spray Deposition (ESD)” method, and property measurement

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Abstract: This investigation revealed the NiO growth mechanism for solution-dependent electrostatic spray deposition (ESD). For the preparation of ESD spray solutions, solvent Nickel (II) acetylacetonate ($Ni(C_5H_7O_2)_2$) was mixed with the solute 2-methoxy ethanol (C_3H_8O) and doped with hydrochloric acid (HCl (aq)). In order to uncover the process for behind formation of the NiO thin film, ESD was also used to investigate the large number of microstructure parameters.

Motivation: The innovative ESD approach, which is a nonvacuum, low-cost deposition methodology for oxide thin film investigation, has not received many scientific reports [1, 2]. However, ESD is simple and easy to understand, it can cover broad regions and has substantial industrial benefits by controlling component ratios.

Experimental method: ESD process was used to fabricate NiO thin films applying RF magnetron sputtering deposited conductive In_2O_3:Ti (ITiO) layers on alkali-free glass substrates. $Ni(C_5H_7O_2)_2$ was dissolved with C_3H_8O to prepare 0.1 M (m/l) precursor solutions doped with 0.2 M (m/l) HCl (aq). ESD deposition was performed for 5 min at 2.0 mL/h solution flow, applying external source 8.0 kV spraying voltage, and followed by 200 °C (air) deposition temperature on the ESD hot plate. The distance between the nozzle and the substrate surface was 2.5 cm. After that, the annealing process was performed at 500 °C temperature for varying the annealing times. Crystallographic orientations were determined via XRD. The fabrication of p-n diodes/solar cells was carried out under the optimum condition NiO/ZnO p–n junction.

Results and Discussion: Representative XRD pattern were shown in Fig. 1. The result clearly shows that the peaks are exhibited at the (111) and (200) diffraction for the fabricated NiO thin film. As the annealing time increasing, the lattice parameters increase, which is consistent with the fundamental theory. This research marks a turning point in cost-effective industrial and commercial applications for ESD-deposited semiconductors films/devices. The properties of the fabricated visible-light-transparent solar cell structure was also studied by NiO/ZnO/ITIO/AFG fabricated by ESD technique with NiO/ZnO p–n junction [2].

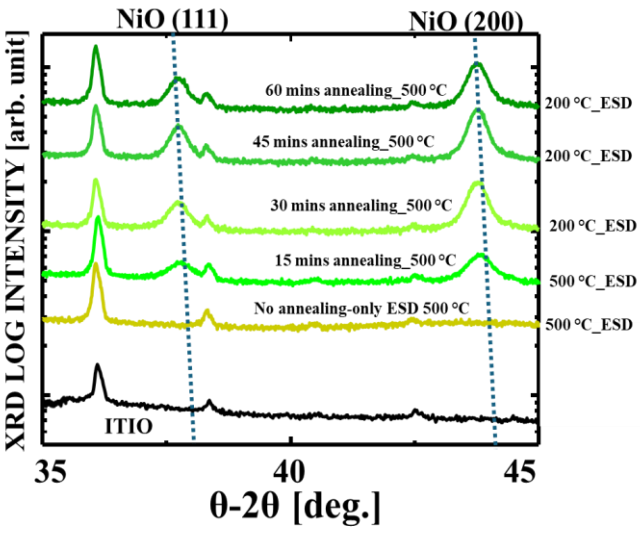

Fig. 1. XRD patterns for the NiO films deposited by ESD.

[1] Our group, Jpn. J. Appl. Phys., **63**, 025504 (2024).
[2] Our group, Jpn. J. Appl. Phys., **63**, 111006 (2024).