Influence of Network Assembly on Thermoelectric Properties of Solution-Processed Graphene Films

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The growing need for sustainable energy technologies has increased the interest in thermoelectric materials for waste heat recovery and energy harvesting applications [1]. Among them, graphene films are attractive due to their high electrical conductivity, tunable electronic transport and scalable solution processing [2]. Most graphene-based thermoelectric studies have focused on chemical doping, composite formulations or defect engineering to improve performance, while the effect of nanosheet assembly and interflake transport on thermoelectric response remains less explored [1,3,4]. In this work, we investigate the thermoelectric properties of electrochemically exfoliated graphene films deposited by nebulization (Neb) and Langmuir–Schaefer (LS) assembly, with thicknesses ranging from a few tens to a few hundred nanometers. The thermoelectric response strongly depends on film thickness and graphene network morphology. LS films form more compact and homogeneous structures, whereas Neb deposition produces more wrinkled and heterogeneous films, which influences interflake transport and scattering processes. LS films reached electrical conductivities up to 1.95×10^5 S/m and power factors up to 83 $\mu W/m^{-1}K^{-2}$ for thicknesses below 70 nm. In contrast, Neb films exhibited lower electrical conductivities, reaching values comparable to LS films only at larger film thicknesses, while maintaining Seebeck coefficients up to 32.7 µV/K. Overall, these results show the strong influence of graphene network morphology and interflake connectivity on thermoelectric transport in solution-processed films.

References

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Figures

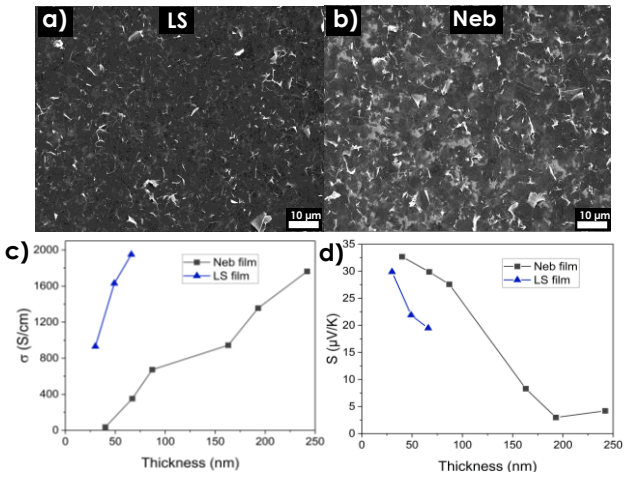

Figure 1: SEM images of graphene films deposited by a) Langmuir–Schaefer and b) nebulization. c) Electrical conductivity and d) Seebeck coefficient as a function of thickness for both graphene films