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Self-Affine Growth of Nylon-Sputtered Nanoparticles

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Rf magnetron sputtering of polymers is known to allow for the synthesis of plasma polymer nanoparticles with controllable size and chemical composition. Morphology of such nanoparticles can be very diverse ranging fascinatingly from smooth to orange-peel or to cauliflower texture. The particular morphology depends on the mechanisms of nucleation and growth. Here, nitrogen-containing plasma polymer particles were synthesized by rf magnetron sputtering of nylon in a gas aggregation cluster source with variable length of the aggregation zone. Spherical particles were produced with the mean size changing from 80 to 320 nm in dependence on the time the particles spent in the source. Markedly, the chemical composition and the particle number density remained constant. The morphogenesis of the particles was investigated by Atomic Force Microscopy with super-sharp probes. The roughness exponent of 0.78, the growth exponent of 0.34 and the dynamic exponent of 0.48 were derived from the advanced surface statistics. These critical exponents point at the self-affine mode of the particle growth and evidence that the particles evolve by the accretion of polymer-forming species from the gas phase and not by coagulation. Non-fractal morphology of the particles implies that the polymer-forming species attach with the probability of less than 100% and that the accretion is accompanied by the substantial redistribution of the incoming material over the particle surface as well as by the development of the inhomogeneously distributed inner stress.
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