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Nanoparticle heating in atmospheric pressure plasmas[1] NICOLAAS KRAMER, University of Minnesota, Mechanical Engineering, ERAY AYDIL, University of Minnesota, Chemical Engineering and Materials Science, UWE KORTSHAGEN, University of Minnesota, Mechanical Engineering — The plasma environment offers a number of attractive properties that allow for the generation of nanoparticle materials that are otherwise hard to produce by other means. Among these are the generally high temperatures that nanoparticles can attain within plasmas, enabling the generation of nanocrystals of high melting point materials. In low pressure discharges, these high temperatures are the result of energetic surface reactions that strongly heat the small nanoparticles combined with the relatively slow heat transfer to the neutral gas. At atmospheric pressure, the nanoparticle intrinsic temperature is much more closely coupled to the neutral gas temperature. We study the heating of nanoparticles in atmospheric pressure plasmas based on a Monte Carlo simulation that takes into account the most important plasma-surface reactions as well as the conductive cooling of nanoparticles through the neutral gas. We find that, compared to low pressure plasmas, significantly higher plasma densities and densities of reactive species are required in order to achieve nanoparticle temperatures comparable to those in low pressure plasmas. These findings have important implications for the application of atmospheric pressure plasmas for the synthesis of nanoparticle materials.

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