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Plasma-assisted surface modifications of powders and granular particles

Philipp Rudolf von Rohr, Denis Butscher, Gina Oberbossel, Vito Giampietro, Roger Wallimann

ETH Zurich, Zurich, Switzerland

philippr@ethz.ch

Non-thermal plasma is a powerful tool for the surface treatment of temperature sensitive substrates, since a low overall process temperature, due to low-energy heavy particles, can be combined with a high reactivity caused by energetic electrons. In addition, such a plasma treatment allows to beneficially influence substrate surface properties like wettability, resistibility, flowability, electrochemical characteristics or microbial contamination, while bulk properties can be kept mostly unaffected. With a reactive gas plasma (e.g. oxygen containing plasma) wettability and dissolution behavior of powders can be increased by incorporating polar oxygen groups into the substrate surface. We successfully applied this approach to HDPE powder and salicylic acid powder by plasma treatment in a low pressure tubular plasma reactor for only 0.1 seconds. We also transferred this technique to the atmospheric pressure domain where we developed a novel plasma device based on the dielectric barrier discharge principle and applied it for the treatment of PMMA substrates and HDPE powders. In a second type of process, coherent films or scattered nanoparticles can be formed in the plasma zone from the addition of organic or organometallic precursors. While the deposition of a coherent film can act as a protective layer or a catalyst, the attachment of nanoparticles (spacers) to the surface allows to increase the flowability of the substrate powder. We successfully implemented these processes in low pressure plasma systems and currently are transferring them to the atmospheric pressure domain. Furthermore, we are investigating the feasibility of graphite powder coating for the improvement of capacity retention and electrolyte compatibility in battery applications. Another utilization of non-thermal plasmas is the inactivation of microorganisms caused by plasma-generated reactive species (charged particles, reactive neutrals, UV photons). We applied this technique for the decontamination of wheat grains in a low-pressure plasma circulating fluidized bed reactor and an atmospheric pressure dielectric barrier discharge. Currently, we are investigating the inactivation of microorganisms on sprout seeds.

Keywords
surface modification