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Treatment of soft-PVC with dielectric barrier discharge to reduce the migration of plasticizersThomas Neubert¹, Veysel Zeren¹, Kristina Lachmann², Michael Thomas²¹Fraunhofer IST, Braunschweig, Germany ²Fraunhofer IST, Braunschweig, Germany

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Polyvinyl chloride (PVC) is a frequently used, cost-effective and very durable polymer. For many of its applications (e.g. blood bags, medical tubes, flooring laminate, electrical insulation) a high flexibility of the material is required. Therefore, considerable amounts of plasticizers (in the order of 40% by weight) are added to produce so-called soft-PVC. As these plasticizers are not chemically bound to the PVC, migration may occur. This leads to a shortened service life of these PVC products due to embrittlement or migration of plasticizers into the surrounding material. The latter is particularly critical for applications in the medical sector, as the plasticizers used here are often harmful phthalates that accumulate in the human body as a result. We have found that by treating soft-PVC surfaces in a dielectric barrier discharge under atmospheric pressure in argon gas, the migration of plasticizer molecules from the plastic can be almost completely reduced within treatment times of only 1 minute. To analyze the migration, we exposed the treated surfaces to well-defined amounts of n-decane and measured the dissolved plasticizer amount by ATR-FTIR spectrometry. Since there are no layer-forming precursors, the effect can only be attributed to structural changes of the polymer surface itself. The migration barriers created by this treatment are stable at room temperature for more than 4 months and can withstand short-term heating to 80 °C or storage in aqueous media. In our work we have also investigated the influence of different process conditions (process gas composition, power, treatment time, design of the plasma source) on the migration barrier efficiency for different plasticizers. Especially contamination of the argon gas with more than 1% oxygen or hydrogen led to a significant reduction of the barrier efficiency. Furthermore, the influence of short-wave UV radiation generated in the plasma was studied as well.

Keywords

PVC

plasma treatment

plasticizer

migration barrier