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Effectiveness of Protective Gloves against Engineered Nanoparticles

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Extended Abstract

For several years, research has been conducted on the effectiveness of personal protective equipments (PPE) against engineered nanoparticles (ENP). Most of these works have been limited to nanoaerosols and respiratory protective equipments (Ahn and Ellenbecker 2006, Golanski et al. 2009a). But recently, limited number of groups has reported research on dermal protective equipments such as nitrile rubber or latex disposable gloves (Vinches et al. 2011).

However, in some cases, conflicting results have been found. For example, the penetration of 30 and 80 nm graphite nanoparticles through nitrile, vinyl, latex and neoprene commercial glove samples has been reported (Golanski et al. 2009a). Few months later, no penetration was measured for the same gloves when exposed to 40 nm graphite, 10 nm titanium dioxide (TiO_2) or 10 nm platinum particles (Golanski et al. 2009b). In 2011, Park et al. have also concluded to a non-penetration of silver nanoaerosol through latex and nitrile rubber protective gloves (Park et al. 2011). In 2013, Vinches et al. have measured a significant penetration of TiO_2 nanoparticles in water through nitrile rubber gloves under conditions (mechanical deformations) simulating occupational use (Vinches et al. 2013). Recently, the same authors have shown the reduced effectiveness of nitrile rubber gloves against 50 nm gold nanoparticles (Vinches et al. 2014). But this last result strongly depends on the thickness of the glove but also on the nitrile rubber glove model and its serial production (work non-published).

Considering these conflicted results, the objective of this work is to determine some influencing parameters which can facilitate or delay the passage of ENP through disposable protective gloves. These parameters can be linked to the ENP such as the size, the shape and the application form (nanoaerosols or suspensions). But also they can be related to the macro structures of the gloves (thickness, surface features, chemical composition and fillers) and the micro elastomeric chain structures (degree of crosslinking and crystallization degree).

Moreover, subjected to mechanical deformations or chemical agents (liquid carrier of the ENP or a physiological solution simulating human sweat), the macro and the micro structures of the glove samples can be significantly modified. In each case, a loss of integrity of the elastomeric membrane can be observed which affects the penetration through the disposable protective gloves.

Finally, a summary of the literature results and our own results will make some recommendations about the models of disposable gloves to wear according to the used ENP. However, it is important to investigate more research in this field to understand the mechanisms of penetration of ENP and the different interactions between the ENP and the elastomeric chains to suggest improvements of glove materials against ENP.

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