

# The effect of microstructured surfaces on the impaction of monodispersed polystyrene microsphere particles

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Particles bouncing on the impaction plate is considered to be a major problem during inertial impaction used as sampling method. The latter can lead to low collection efficiency, a larger impaction zone, and a disagreement between theoretically and experimentally derived cut-off diameters ( $d_{50}$ ). Using sticky materials such as oil/grease on the impaction plate or fiber-porous structures to allow the particles to penetrate the structures, reduces the rebound effect (Baron and Willeke, 1993). Microfabrication methods are used to create specific attachment areas on the surface where micro/nanostructured surfaces can be developed. Some studies have shown that for a dense configuration of micropillars, the local collection efficiency is higher than for other configurations (Hajizadehmotlagh and Paprotny, 2020). In order to enhance the effect of micro-nanostructured surfaces on monodispersed polystyrene microsphere particles impaction, several surfaces of interest are fabricated. The flat silicon (Si) is considered as a reference surface, the latter is modified by photolithography and etching process, to obtain microstructured surfaces such as silicon micropillars of circular shape with 5 and 10  $\mu\text{m}$  in diameter (spacing separating the pillars varies among 2, 5, 10 and 15  $\mu\text{m}$ ; where the height is fixed at 15  $\mu\text{m}$ ).

An impaction bench has been designed and put in place for the aim of this study. A Collision nebulizer method was used, as it is a recognized technique for the efficient aerosolization of various liquids; which is, in this case, the polystyrene microspheres suspension in filtered water (May, 1973).

To study the deposition characteristics of the particles, monodispersed microspheres has been generated with various aerodynamic median diameter ( $0.79 \pm 0.12$   $\mu\text{m}$  and  $3.19 \pm 0.49$   $\mu\text{m}$ ). These particles have been impacted on flat silicon surface, and silicon micropillars using a lab-made impactor with  $d_{50} = 0.4$   $\mu\text{m}$  and 500  $\mu\text{m}$  nozzle diameter.

Halo-shaped, ring-shaped have been observed on silicon as preliminary results. These shapes are caused by the rebound and re-entertainment of the particles on a flat silicon surface. As the particles diameter increase, the deposits have changed from halo to ring shape. The large particles diameter tends to enlarge the ring. However, deposits on micropillars

surfaces showed different shapes depending on the spacing between the pillars. For dense configuration; i.e. small spacing between the pillars; a localized circular deposition pattern (dia < 500  $\mu\text{m}$ ) is obtained underneath the nozzle which is smaller than the nozzle diameter. Figure 1. presents the shapes of the impaction spot for polystyrene microsphere ( $0.79 \pm 0.12$ )  $\mu\text{m}$ . On the other hand, for a dispersed configuration; i.e. large spacing between the pillars; a star shape pattern is noticed. The latter is may be due to the high void and the penetration of the impinging jet between the pillars during impaction. The circular shaped micropillars with dense configuration have enabled to reduce bouncing effect, thus have provided a confined deposition pattern underneath the nozzle. Some results show that the local collection efficiency is increased for microstructured surfaces with dense configuration.

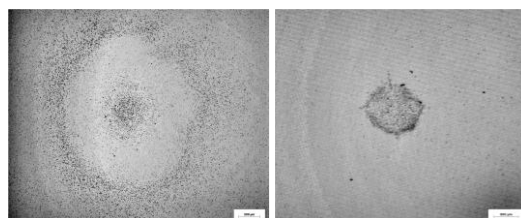


Figure 1. The shapes of the spot on silicon (left image) and micropillars with dense configuration (right image)

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