According to a first aspect, there is provided a brush for cleaning of substrates following chemical mechanical polishing (post-CMP) of the substrates comprising: a generally cylindrical body; a plurality of central nodules projecting outwardly from the cylindrical body in a central region of the body, the central nodules being spaced apart from each other and separated by central gaps; a plurality of edge nodules projecting outwardly from the cylindrical body and having a different shape than the central nodules, a first set of edge nodules disposed between the central region and a first end of the body and a second set of edge nodules disposed between the central region and a second end of the body, the central nodules being spaced apart from each set of edge nodules by edge gaps; and wherein: adjacent circumferential columns of edge nodules and central nodules are provided in a staggered, interlaced alignment around the body such that the edge gaps between the edge nodules and central nodules do not form a straight annular channel extending circumferentially around the body; a top surface of each edge nodule has a greater surface area adapted to contact a substrate than a surface area of a top surface of each central nodule; and the top surfaces of the edge nodules and the top surface of the central nodules extend substantially a same height from the body.

According to a second aspect, there is provided a method of post CMP cleaning of a surface of a semiconductor wafer, the method comprising: engaging the surface of a rotating wafer with a rotating cylindrical foam roller, the cylindrical foam roller having a first circumferentially extending row of elongate nodules and a second circumferentially extending row of elongate nodules, each circumferentially extending row of elongate nodules extending around the cylindrical foam roller, each of the nodules having a side surface and an outer wafer engagement surface, each of the elongate nodules oriented at least primarily in an axial direction, positioning the roller on the wafer such that the row of elongate nodules are positioned having the edge of the wafer engage only the outer wafer engagement surfaces of the elongate nodules and not the side surfaces.

According to a third aspect, there is provided a cylindrical foam roller for post CMP cleaning of wafers, the cylindrical foam roller having an axis and a cylindrical outer base surface with a matrixical arrangement of nodules extending from the cylindrical outer surface, the nodules all extending out a uniform distance from the axis, the nodules extending circumferentially around the cylindrical foam roller, each of the nodules oriented with their elongate dimension extending more in an axial direction than a circumferential direction and wherein the nodules are not all of a uniform top surface area, wherein the matrixical arrangement of nodules includes a multiplicity of cylindrical nodules extending radially outward from the outer cylindrical surface of the foam roller.

Embodiments of t~~T~~he present invention disclose~~is~~ a post-CMP cleaning brush that can be used to clean various substrates such as semiconductor wafers, hard disks, flat panels and the like. The post-CMP brush has a combination of central nodules at an inner region of the brush and one or more edge nodules at or near end regions of the brush. The central nodules and edge nodules can be in a staggered or matched arrangement with each other and an upper surface of each edge nodule on the brush has the same or a greater contact area than an upper surface of a central nodule. The area of contact of the upper surface of each edge nodule with a substrate edge region is the same or greater than the area of contact of the upper surface of a central nodule with a substrate center region. The heights of the tops of the central nodules and heights of the tops of the edge nodules are substantially the same, or are the same within about ±5%, or less, of a mean height for the nodules as measured for example from an axis of rotation of the brush. The nodules at the near end region of the brush lack a profile of the substrate.

A post CMP cleaning brush according to an embodiment of the present invention includes a cylindrical foam brush with a first end and a second end, the brush has an outer surface and a plurality central nodules and a plurality of edge nodules on a surface of the brush. The central nodules are located in a center region of the brush and the central nodules are separated from each other by gaps. The edge nodules are located near the first end and near the second end of the brush and the edge nodules and are separated from the central nodules by gaps. The central nodules and edge nodules are arranged on the surface of the brush such that no straight line channel running annularly around the brush is formed by central nodules or edge nodules. The central nodules have a top surface and a central nodule top surface height measured from a rotational axis of the brush to the central nodule top surface. The edge nodules have a top surface and a edge nodule top surface height measured from the rotational axis of the brush to the edge nodule top surface. The central nodule top surface height and the edge nodule top surface height are the same or differ by an amount less than an edge profile portion of the substrate. The area of a top surface of an edge nodule is greater than the area of a top surface of a central nodule and the area of the top surface of an edge nodule is less than the area encompassed by four, or fewer, central protrusions.

In some embodiments of the invention the arrangement of central nodules and edge nodules results in a brush where the friction between the brush and a substrate is within