

SUPPORTING INFORMATION PARAGRAPH.

Scanning electron microscopy (SEM).

SEM observations were carried out by employing a Zeiss EVO LS15 microscope. The observations were carried out for powders that have undergone 0, 1000, 2000, 4000 and 6000 collisions. In each case, ten to fifteen samples of ground quartz powders were investigated with the aim of extracting a representative set of data regarding the statistical distribution $p(d)$ of the size d of powder particles. About 120 particles per sample were counted, which means that the total number of particle sizes measured was in the range between 1200 and 1800. Such numbers are large enough to assure a satisfactory statistics even in the case of bi-modal distribution curves such as the ones observed in the present work.

The distribution curves $p(d)$ obtained after 1000 and 6000 collisions are shown in Figure SI1.

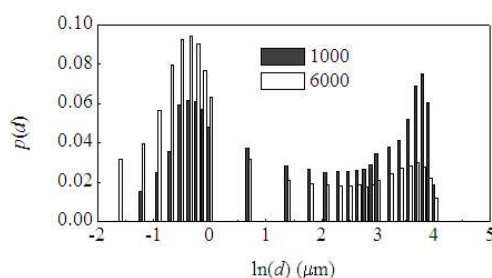


Figure SI1. The statistical distribution $p(d)$ of the size d of quartz powders. For clarity, a logarithmic scale is used. Data refer to quartz powders submitted to 1000 and 6000 collisions.

It can be seen that the $p(d)$ curves exhibit a clear bimodality, with peaks roughly around 0.6 and 50 μm , originating from the crushing events consequent to the mechanical load experienced by powder particles at collisions. The relative height of the two peaks changes with the number n of collisions. In particular, the height of the peak at 0.6 μm increases as n increases, whereas the height of the peak at 50 μm decreases.

Apart from the initial powders, characterized by a narrow size distribution between 53 and 44 μm , bimodality is common to all of the observed powder samples.

Surface density of active sites.

Regarding the surface density β of active sites generated by attrition, an independent estimate was obtained by using quartz powders with different final values S_{fin} of the specific surface area. The quartz powders were prepared in commercial high-energy ball mills. Grinding was carried out on 4 g of powders in the presence of 20 ml of ethanol and two grinding balls. The mechanical processing was performed at impact energy values roughly between 0.08 and 0.24 J. The treatment was prolonged for over 48 h. At the end of the treatment, the obtained powders exhibit narrow size distributions $p(d)$ around average d values equal to about 0.6, 0.2, 0.12 and 0.09 μm .

In all of the cases, the decrease of the size d and the corresponding increase in specific surface area S were followed as a function of the number n of collisions respectively by SEM observation and by nitrogen physisorption. The trends of S data are invariably similar to the one shown in Figure 3b. The experimental S points were interpolated by Eq. 1. The corresponding surface area S_{fin} estimates amount to about 3.69, 11.79, 18.84 and 24.67 $\text{m}^2 \text{g}^{-1}$.

For any given batch of powders, a total mass of 2 g was processed in the mechanochemical reactor schematically described in Figure 1 in the presence of 30 ml of ethanol solution containing 1 M of the free radical DPPH. The DPPH consumption process was followed by UV-Vis spectrophotometry. The results obtained are shown in Figure SI2, where the number N_{DPPH} of DPPH moles in ethanol solution are plotted as a function of the number n of collisions occurred.

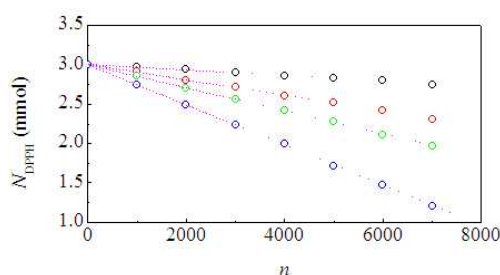


Figure SI2. The number N_{DPPH} of DPPH moles in ethanol solution as a function of the number n of collisions occurred. Best-fitted lines are also shown.

It can be seen that N_{DPPH} always decreases according to linear trends. The different rates observed, i.e. the different slopes of the linear plots, are proportional to the specific surface area S_{fin} of quartz powders. This means that the different quartz powders exhibit roughly the same value of the surface density β of active sites generated by attrition.

Eq. 4 was used to best-fit the experimental N_{DPPH} points. The S_{fin} values estimated by the best-fitting of the experimental S points were used in Eq. 4. The obtained β values amount to 4.6×10^{-6} , 4.1×10^{-6} , 3.9×10^{-6} , and 5.2×10^{-6} mol m⁻² respectively for powders exhibiting S_{fin} values roughly equal to 3.69, 11.79, 18.84 and 24.67 m² g⁻¹. On the average, the surface density β of active sites generated by attrition between quartz surfaces is equal to 4.5×10^{-6} mol m⁻². The agreement between the best-fitted line and the experimental points is quite good, with the linear regression coefficient equal to about 0.99.