Modelling of stressing characteristics in media mills

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ABSTRACT

Media mills are commonly used for dry processing of particle powders in application to grinding, mechanochemical synthesis or mechanical alloying. The limitation of planetary and high energy mills on laboratory scale makes these mills a tool for scientific and screening experiments where a fundamental understanding or even a subsequent up-scale is necessary.

The power input which is used to evaluate the process can be experimentally measured by torque sensors. However, torque sensors are often no production standard, so that either elaborate setup changes are needed or the process and its power input is described via numerical models. The DEM simulation allows identifying not only the power input, but the intensity and frequency of particle stressing, which is not accessible by experiments. The media are modelled as discrete elements while the powder particles are not shown explicitly but taken into account by the coefficients of friction and restitution. The friction and damping conditions have a significant influence on the motion pattern of the media charge [1] and need to be adjusted carefully. Thus, a series of experiments [2] from drop tests to angle of repose is used to determine the correct coefficient of friction and restitution. The simulations are validated by the comparison of experimentally measured power and simulated power input which are linearly interdependent.

In this study, the simulation of various media mills is presented and the requirement to determine the friction and damping conditions is shown. In dry grinding processes the material tends to form particulate layers on media and beaker surfaces which affect power input and stressing mechanism and are not sufficiently studied yet. By a sensitivity analysis the effects of coefficients of friction and restitution are investigated by DEM simulations and further discussed. The different geometry design and type of agitation of various mills lead to an individual movement pattern of media and, thus, to different stressing mechanisms. The media trajectories are depicted to understand the effect of movement and to identify the optimum state. The movement of grinding beakers is described by mathematical functions. In case of vibrational mills driven by an unbalanced motor, the beaker movement needs to be determined by high speed videos before transferring the moving path of beaker into the simulation. Finally, the advantages and applications of simulations to real processes are briefly presented to show the capability of DEM simulations on dry processes in media mills.

REFERENCES

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