Stabilization of metastable states for sustainable functionalization -From molecular dispersion to spintronics-

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Particulate materials are less stable than a massive single crystal of the same chemical composition, referred as a standard state in the thermodynamics. Functional nanomaterials with crystalline imperfections are thus highly metastable evaluated by excess Gibbs energy [1]. However, many functions of the powdery solids rely upon just such imperfections. Therefore, one of the key issues of materials design is the characterization and control of such imperfections. Imperfection derived function and materials stability is a trade-off issue. Various efforts are paid to control materials stability, e.g. via rapid quenching for bulk amorphous state, capping to keep anomalous surface states or intergranular cosegregation. The author tries to demonstrate severl strategies for stabilizing such “metastable” functional nanomaterials by his own experimental case studies. Characterization of various imperfections is discussed together with sustainability-conscious preparative processes with controlled metastability. Cases studies include:

- Molecular dispersion of drugs with inert or active excepients [2],
- High antisite disorder of spintronic strontium iron molybdate double perovskites, and
- Nanoglassy states of Li-based pyroxene compounds [3].

Common components of these widespread case studies will be summarized in conjunction with particularities of mechanochemical processes.

[1] Chaikina MV et al, Ceram. Int. 45 (2019) 16927.
[2] Watanabe T et al, Int. J. Pharm. 226 (2001) 81.
[3] Turianicova E et al, J. Alloys Compds. 707 (2017) 310.