MECHANOCHEMISTRY. COMPLEXITY OF SIMPLE SYSTEMS.

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A chemical transformation can be induced by heating, by exposing the sample to light, or a shorter-wave radiation. One speaks then of thermochemistry, photochemistry, or radiation chemistry. By analogy, one speaks about mechanochemistry when a chemical transformation is induced by mechanical action. However, the situation is not as simple as that. Mechanochemistry is a very broad field that studies processes ranging from manipulation of individual molecules and atoms by tools of high precision, such as the tip of the atomic force microscope (AFM), allowing the determination of fundamental properties of individual molecules (e.g. the flexibility of protein structures) to co-grinding multicomponent dry mixtures in the mills of different types. One can also add that even without any external mechanical action solid-state transformations themselves are related to generation of mechanical stresses and are in this way intrinsically "mechanochemical". The complexity of the systems which are successfully explored by preparative mechanochemistry grows rapidly. Still, even for simple systems the mechanisms of the transformations and the details of relation between mechanical strain, stress, structural and chemical transformations often remain unclear. In many cases reactions under mechanical action are in fact of thermal origin, many of the so-called "dry reactions" occur in reality in a fluid phase – solution or melt at the interface, or via the sublimation of one or more components. The role of mechanical treatment can range from bringing components into a better contact by mixing to direct breaking chemical bonds. In the present contribution I shall discuss different examples to illustrate the variety of mechanochemical processes. Using very simple mono- and multi-component systems one can study the transformation at the crack tip, the role of fluid phases, the role of relaxation of mechanical stresses between mechanical pulses, the different effects of shear and impact, the role of "inert" additives and many other interesting phenomena. Such detailed studies using model systems and model instruments for mechanical treatment are important to understand the mechanisms of transformations under mechanical action and to optimize them, also for industrially important reactions[1].

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[1] E.V. Boldyreva, Mechanochemistry of inorganic and organic systems: what is similar, what is different? ChemSocRev, 2013, 42 (18), pp. 7719-7738.