

Mechanochemistry - Unconventional Synthesis Routes in Ball Mills

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A major challenge facing today's chemical industry is the reduction of waste, with solvents accounting for the vast majority of it. Mechanochemistry addresses this issue by eliminating solvents entirely and initiating chemical reactions through mechanical energy—delivered locally via ball milling. Building on this approach, a novel concept termed direct mechanocatalysis is introduced, utilizing the milling media or the vessel's inner walls directly as the active catalyst and bypassing the need for dissolved or powdered catalysts. The continuous collision of the milling balls constantly refreshes their catalytically active surfaces, enabling traditionally solvent-dependent C–C cross-coupling reactions—such as Suzuki, Sonogashira, Heck, and Glaser couplings—to proceed efficiently. The presentation further highlights recent achievements in combining mechanochemistry with complementary techniques, including photochemistry and gas-phase chemistry. Finally, advanced in situ techniques are presented that allow for the investigation of real-time mechanochemical reaction mechanisms, addressing fundamental questions regarding the role of temperature and activation energies in these transformation processes.