Editorial corner – a personal view

Mechanochemical synthesis and modification of polymers

Gy. Bánhegyi*

Department of Advanced Materials and Processes Institute for Materials Science and Technology, Bay Zoltán Nonprofit Ltd. for Applied Research, Fehérvári út 130., H-1116 Budapest, Hungary

Polymers are usually synthesized in gas and liquid phases by polymerization, polycondensation, polyaddition. There have been extensive attempts at solid state polymerization induced by various kinds of irradiation, but the differences in lattice symmetry usually prevented the direct formation of crystalline polymers from monomers. Mechanochemical synthesis became a common route in inorganic solid state chemistry.

Recent publications (see e.g. DOI: [10.1021/mz500098r](https://doi.org/10.1021/mz500098r), DOI: [10.6000/1927-5951.2014.04.01.6](https://doi.org/10.6000/1927-5951.2014.04.01.6)) show, that ball milling can also be used for direct polymer synthesis and not only for the uniform distribution of fillers in a polymer matrix (see e.g. DOI: [10.1177/0731684412471230](https://doi.org/10.1177/0731684412471230), DOI: [10.1002/app.35413](https://doi.org/10.1002/app.35413)) or for coating inorganic nano particles (DOI: [10.1016/j.powtec.2010.11.011](https://doi.org/10.1016/j.powtec.2010.11.011), DOI: [10.1039/C1JM10819K](https://doi.org/10.1039/C1JM10819K)).

In some cases embedding into a polymer goes parallel with ion doping (see e.g. DOI: [10.1021/am4056672](https://doi.org/10.1021/am4056672), where Li doped Si is combined with polypara-phenylene polymer for Li batteries). Mechanochemistry can be well utilized for the polymer-analog modification of already existing polymers (see e.g. DOI: [10.1021/cg500439f](https://doi.org/10.1021/cg500439f)) or for block-polymerization (DOI: [10.1155/2014/127506](https://doi.org/10.1155/2014/127506)). The mechanism of the latter is not much different from that used in compatibilization by reactive extrusion: radicals recombine with each other.

The advantage of the mechanochemical route is the reduced solvent consumption, or complete elimination of the solvent (environmentally benign

processes, ‘green chemistry’), parallel processes (breakdown of particles, surface grafting, embedding, polymerization, block-copolymer formation, compatibilization) may proceed and the specific energy can be very high. The resurgence of the interest in mechanochemical methods is partly due to their applicability in waste disposal and recycling (DOI: [10.1016/j.wasman.2009.08.017](https://doi.org/10.1016/j.wasman.2009.08.017)). Harmful chemicals may be mechanically degraded into less harmful products, partial network degradation of rubbers (DOI: [10.4028/www.scientific.net/AMR.239-242.2503](https://doi.org/10.4028/www.scientific.net/AMR.239-242.2503)) and thermoset polymers (DOI: [10.2417/spepro.005351](https://doi.org/10.2417/spepro.005351), DOI: [10.4028/www.scientific.net/AMM.130-134.1708](https://doi.org/10.4028/www.scientific.net/AMM.130-134.1708)) can be achieved. Surface activation and treatment are performed simultaneously, which allows the production of active fillers from the otherwise intractable thermoset composite waste. Another aim is the wider utilization of natural polymers (DOI: [10.1039/B108255H](https://doi.org/10.1039/B108255H), DOI: [10.1155/2013/425726](https://doi.org/10.1155/2013/425726)), and even the synthesis of biomimetic polymers (DOI: [10.1038/nchem.1938](https://doi.org/10.1038/nchem.1938)). For the above reasons I foresee and expect an increased research and development activity in the field of mechanical synthesis and modification of polymers.

Dr. György Bánhegyi
Member of Executive Editorial Board

*Corresponding author, e-mail: gybanheg@t-online.hu
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