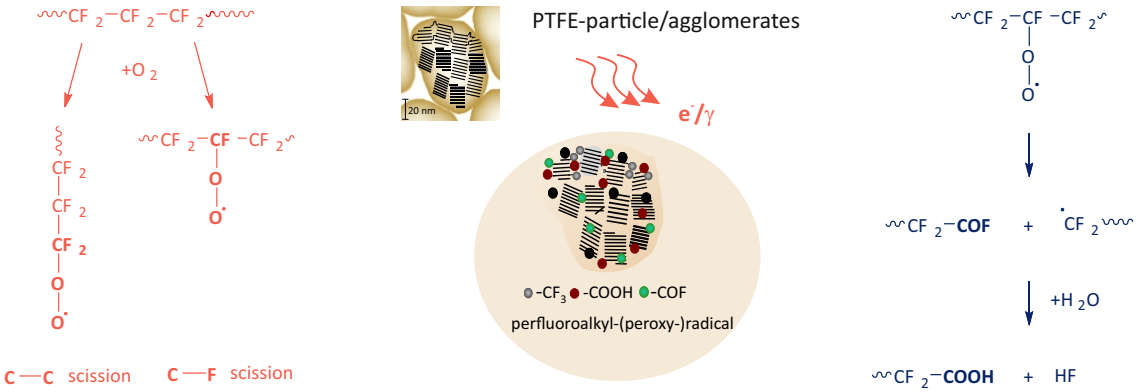
Leibniz-Institut
für Polymerforschung
Dresden

Chemically bonded polyamide-PTFE-oil materials for low-wear and low-maintenance tribological applications

Motivation

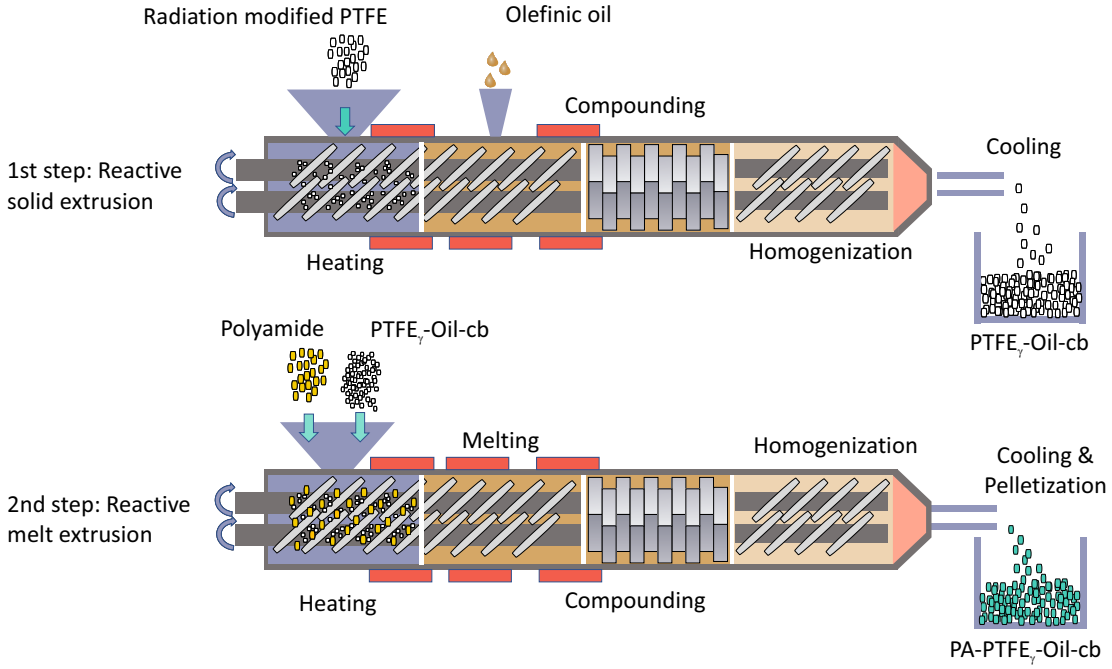
In applications under extreme temperature conditions, conventional lubricants no longer serve their purpose due to poor lubricant film formation or limited heat transfer. Solid lubricants are therefore frequently used, with poly(tetrafluoroethylene) (PTFE) being particularly suitable due to its especially low coefficient of friction and other unique properties, such as extreme chemical stability. The disadvantage is that pure PTFE exhibits high wear, is incompatible with most polymer materials and cannot be processed by thermoplastic methods. In contrast, polyamides (PA) are easy to process and have very good mechanical properties. Based on fundamental IPF work on PTFE functionalization via high-energy radiation, chemical coupling of PA with PTFE was realized and tested in tribo pairings at moderate loads. In addition to low coefficients of friction, the compounds showed dramatically improved wear resistance.

PTFE treatment by high-energy irradiation

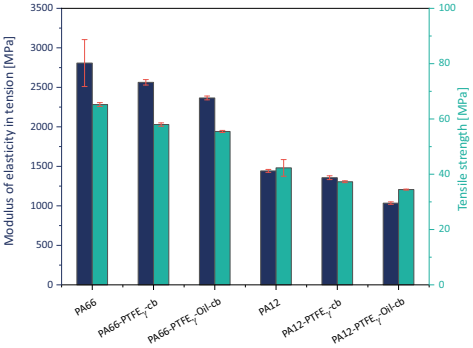


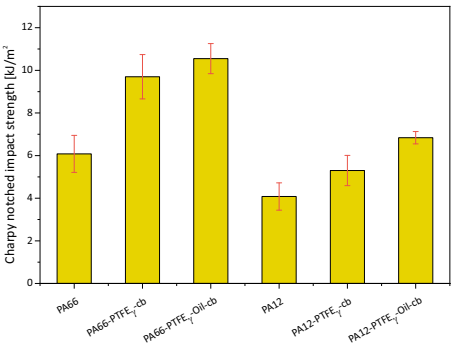
Shortened mechanism to enhance the PTFE compatibility and for the generation of reactive groups

Material processing by two-step reactive extrusion

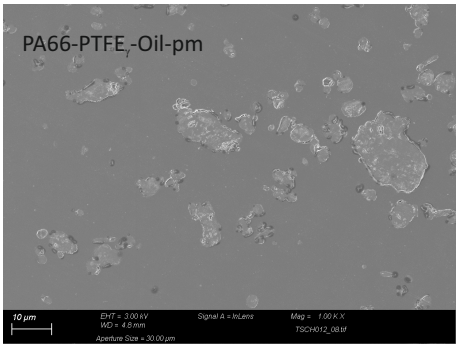


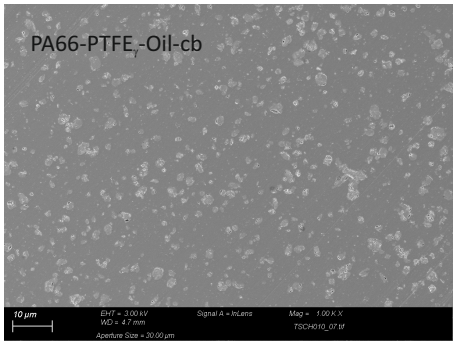
Selected properties of the PA-PTFE-Oil materials



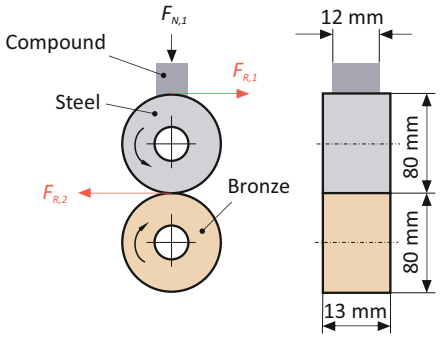


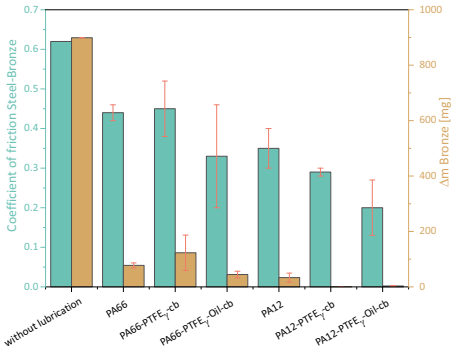
Mechanical properties of the compounds in comparison to the virgin PA and PA-PTFE$_\gamma$-cb





SEM images of physically mixed (pm) and chemically bonded (cb) compounds





Scheme of the block two-disk test rig (source: MEGT Kaiserslautern) and tribology results

Innovative advantages of the chemical coupling of PA, PTFE and Oil

- Chemical coupling of oil molecules enables further reduction of coefficient of friction and wear in direct friction pairings and as a sacrificial element, even at higher mechanical loads, and thus significantly improved long-term stability
- Optimal compatibilization, breakdown and distribution of PTFE particles in the polymer matrix
- Mostly retained bulk properties of the material
- Substantial increase in impact strength compared to the plain polymer matrix

Contact

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DFG Deutsche Forschungsgemeinschaft

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