

Palladium-catalyzed cross-coupling and carbonylation reactions under mechanochemical conditions

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Metal-catalyzed cross-coupling reactions enable the synthesis of various complex molecules. Despite their widespread use, several challenges hinder their application. The use of sensitive transition-metal catalysts and organometallic reagents is a significant limiting factor. Mechanochemistry seeks to address these issues. Recent studies have demonstrated that metal-catalyzed cross-coupling reactions can be performed effectively under mechanochemical conditions [1].

Our team studied the mechanochemical cross-coupling of organozinc pivalates with aryl halides [2]. We continued this work by forming other organozinc species in situ, such as Reformatsky enolates under mechanochemical conditions, followed by mechanochemical Pd-catalyzed cross-coupling [3]. Recently, we have also studied the application of aryl thianthrenium salts as alternative electrophiles in Pd-catalyzed cross-coupling reactions with organoboron and organozinc compounds [4]. Additionally, we discovered that Pd-catalyzed carbonylation of aryl halides or aryl thianthrenium salts with amines and phenols can be achieved under mechanochemical conditions. In these cases, we used solid $\text{FeBr}_2(\text{CO})_4$ as a CO source [5,6]. Our findings indicate that mechanochemistry can enable more sustainable metal-catalyzed cross-coupling reactions, allowing operations under ambient conditions in air, even with sensitive organometallic reagents.

References

- [1] Kubota, K.; Ito, H. Mechanochemical Cross-Coupling Reactions. *Trends Chem.* 2020, 2, 1066–1081.
- [2] Čarný, T.; Peňaška, T.; Andrejčák, S.; Šebesta, R. Mechanochemical Pd-Catalyzed Cross-Coupling of Arylhalides and Organozinc Pivalates. *Chem. Eur. J.* 2022, 28, e202202040.
- [3] Čarný, T.; Mravcová, D.; Steinhübllová, B.; Šebesta, R. *Adv. Synth. Catal.* 2025, 367, e202401403.
- [4] Mravíková, Z.; Peňaška, T.; Horniaková, D.; Šebesta, R. *ChemSusChem* 2025, 18, e202402599.
- [5] Čarný, T.; Kisszékelyi, P.; Markovič, M.; Gracza, T.; Kooš, P.; Šebesta, R. *Org. Lett.* 2023, 25, 8617–8621.
- [6] Yadav, S.; Čarný, T.; Šebesta, R. *Org. Lett.* 2026, 28, 7260–7265.