

Review of: "Simultaneous construction of axial and planar chirality by gold/TY-Phos-catalyzed asymmetric hydroarylation"

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Chiral molecules hold a special place in synthetic chemistry, medicinal chemistry, materials, and many other interdisciplinary fields. However, general asymmetric catalytic approaches provide compounds with only one type of chiral element, such as center, axial, planar, or helical chirality. In this work, Zhang and coworkers have reported a gold-catalyzed asymmetric hydroarylation of *ortho*-alkynylaryl ferrocenes for the simultaneous construction of axial and planar chirality in these generated PAHs. Although the utility is not very clear so far, the development of novel catalytic method for the construction of chiral entities with more than one type of chirality is interesting and appealing considering the diversified asymmetric elements in biomolecules and chiral recognition in a variety of bioactivity processes.

There are several concerns and potentials with this study which include the following:

1. Installation of multi-stereochemical elements within a single step is intrinsically challenging and has been rarely reported. In this work, the author developed an effective strategy for the synthesis of PAHs with simultaneous construction of planar and axial chirality by an Au-catalyzed asymmetric intramolecular hydroarylation with "homemade" chiral TY-Phos ligands in one step. These chiral PAHs are isolated in high to excellent yields with generally around 90% ee. The excellent diastereoselectivities could be obtained by increasing the steric hindrance of the substitution group on the *ortho*-position. Thus, further optimization could be envisioned by modification of the chiral ligands or catalytic conditions to enable high stereoselectivity with broad substrate scope.
2. The catalytic alkyne cyclization has been one of the practical reactions for the construction of aromatic rings. In addition to the axial and planar chirality, this work would inspire the synthetic chemists to develop novel catalytic methods for the synthesis of chiral PAHs with diverse combination of different chirality.
3. Due to the unique linear geometry of the corresponding key intermediates in gold-catalyzed alkyne functionalization, there are only few limited examples of chiral gold complexes that have been disclosed to exhibit high enantioselectivity in catalytic alkyne transformations. Thus, this work not only shows an additional example of asymmetric catalytic alkyne functionalization, but also demonstrated a novel gold complex that could be potentially subjected to a variety of asymmetric transformations after the

structure optimization.

4. In this work, the authors have also conducted the DFT calculation to rationalize the asymmetric introduction and stereo-determination steps. It's also very important to illustrate the chirality transfer process. For example, recent work by Xu and Yu has disclosed a transient-axial-chirality controlled "axial to point chirality transfer" process for the asymmetric alkyne functionalization (Nat. Commun. 2020, 11, 2363). These detailed mechanism study would be the primary task and very useful for the selective construction of chiral molecules that possess more than one chiral element.