

Guest(Solvent)-Dependent Enantioselective Crystallization of 7-Bromo-1,4,8-triphenyl-2,3-benzo[3.3.0]octa-2,4,7-trien-6-one As the Inclusion Complex

Fumio Toda* and Koichi Tanaka

Department of Industrial Chemistry, Faculty of
Engineering, Ehime University, Matsuyama 790, Japan

(Received 2 May 1990)

Abstract: The optical resolution of the title compound is easily achieved by its preferential crystallization as an inclusion complex with the solvent used for the crystallization.

The title compound (**1**)¹ has been found to include a wide variety of solvent as guests and form crystalline inclusion crystals. In the inclusion crystallizations, racemates or conglomerates of **1** were formed depending on the choice of solvent. In the latter case, the inclusion crystals consisting of one enantiomer of **1** were formed preferentially and the optical resolution of **1** could be performed.

Recrystallization of *rac* **1** from the solvents shown in Table 1 gave a 1:1 inclusion crystal of the *rac* **1** with the solvent as yellow crystals (Table 1). On the other hand, recrystallization of the *rac* **1** from the solvents shown in Table 2 gave 1:1 inclusion crystals of the optically active **1** with the solvent as yellow crystals (Table 2). For example, recrystallization of the *rac* **1** (mp 185-186 °C) from THF gave a 1:1 inclusion complex of the optically active **1** and THF, each single crystal consisting of optically pure (+)- or (-)-**1**. By seeding with one crystal of optically pure **1** during the recrystallization of *rac* **1**, a large quantity of the optically pure **1** could be obtained.

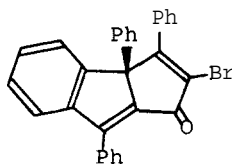

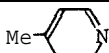





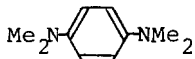


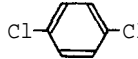


Table 1. Formation of 1:1 Inclusion Crystals of
 Rac Compound of **1** with Solvent (Guest)^a

| Solvent (Guest) | Mp/°C | Photo- chromism ^b | Solvent (Guest) | Mp/°C | Photo- chromism ^b |
|---|-----------------|---------------------------------|---|---------|---------------------------------|
|  | 112-115 | + |  | 100-102 | + |
|  | nd ^c | + |  | 59-61 | |
|  | nd | |  | 145-149 | - |
|  | 109-112 | + |  | 177-179 | - |
| CHCl ₃ | 101-105 | + |  | 159-165 | + |
| CHBr ₃ | 129-135 | |  | 88-90 | + |
| CH ₂ Cl ₂ | nd | + | | | |
| PhOMe | 127-131 | + |  | 132-138 | + |




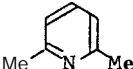






^aAll inclusion compounds are formed as yellow crystals. ^bVarious colors appear depending on a kind of the solvent included.

^cNot distinct.

For example, to a solution of the **rac 1** (10 g) in THF (50 ml) was added one piece of the crystal of the (+)-**1**·THF complex and the mixture kept at room temperature for 12 h to give the (+)-**1**·THF complex, after one recrystallization from THF, 0.81 g (14% yield, 100% ee, $[\alpha]_D^{20} +479.8$ (*c* 0.21 in CHCl₃)). Distillation of THF from the complex in *vacuo* gave (+)-**1** of 100% ee (0.7 g, 14% yield, mp 234-236 °C, $[\alpha]_D^{20} +480$ (*c* 0.41 in CHCl₃)). To the filtrate left after filtration of the crude (+)-**1**·THF complex, one piece of the crystal of the (-)-**1**·THF complex was added and the solution was kept at room temperature for 12 h to give the (-)-**1**·THF complex, after two recrystallizations from THF, 1.1 g (19% yield, 100% ee, $[\alpha]_D^{20} -479.5$ (*c* 0.20 in CHCl₃)). Distillation of THF from the complex in *vacuo* gave (-)-**1** of 100% ee (0.96 g, 19% yield, mp 234-236 °C, $[\alpha]_D^{20} -480$ (*c* 0.41 in CHCl₃)). Optical purity of the (+)- and (-)-**1** was determined by HPLC using a column containing an optically active solid phase, YMC A-K03.²

Some inclusion crystals summarized in Tables 1 and 2 showed photochromism and various colors appeared depending on a kind of solvent included. X-Ray crystal structural studies of the crystals which show this photochromism will be reported in the near future.

Table 2. Formation of 1:1 Inclusion Crystals of Rac Mixture of **1** with Solvent (Guest)^a

| Solvent (Guest) | Mp/°C | Photo-chromism ^b | Solvent (Guest) | Mp/°C | Photo-chromism ^b |
|---|-----------------|-----------------------------|---|---------|-----------------------------|
|  | 112-114 | |  | 135-139 | + |
|  2 | nc ^c | |  | 98-102 | t |
|  | 120-125 | + |  | 119-123 | - |
|  3 | nd | - | MeI | nd | |
|  | 122-128 | + | EtBr | na | |
|  | nd | | EtI | na | |
|  | nd | | CCl ₄ | 127-130 | + |
| | | | CBr ₄ | 129-134 | + |

^aAll inclusion compounds are formed as yellow crystals. ^bVarious colors appear depending on a kind of the solvent included.

^cNot distinct.

It is interesting to note that the solvents which form complexes with *rac* **1** do not form complexes with optically active **1** and vice versa. For example, the powdered (+)-**1** obtained by the evaporation of THF from the (+)-**1**·THF complex turns to guest-free crystals by recrystallization from benzene. The difference of the role between the solvents shown in Tables 1 and 2 will be clarified by X-ray crystal structural studies of the inclusion complexes.

By using optically active **1** for the complexation, some guest compounds could be resolved. For example, when a solution of (-)-**1** (1.3 g) in *rac* 2-methyltetrahydrofuran (**2**) (5 g) was kept at room temperature for 12 h, a 1:1 inclusion complex of (-)-**1** and (-)-**2**³ was formed as yellow prisms (1.32 g), which upon distillation gave (*R*)-(-)-**2**³ of 32% ee (0.1 g, 4% yield, $[\alpha]_D^{20}$ -6.4 (*c* 0.96 in CHCl₃)). The optical purity was determined by comparison of the $[\alpha]_D$ value with that of an authentic sample.³

By the same method, 2-methylpyran (**3**) was resolved by (-)-**1** to give (*R*)-(-)-**3**³ of 30% ee in 8% yield. Although the efficiency of the resolution is not high, chiral recognition between **1** and **2** or **3**, which have no binding groups such as hydroxyl for hydrogen bonding, is interesting.

Further interesting enantioselective complexation between **1** and **3** has been observed. When a single crystal of (+)-**1**·(+)-**3** complex was used to seed at the recrystallization of rac **1** (2.0 g) from rac **3** (20 g), inclusion crystals of (+)-**1** of 99.0% ee and (+)-**3** of 29.4% ee were obtained (0.22 g, 18.6% yield).

Acknowledgement

We wish to thank for the Ministry of Education, Science and Culture, Japan, for Grant-in-Aid for Scientific Research on Priority Areas, No. 63840017.

References and Notes

1. F. Toda, M. Sasaoka, Y. Todo, K. Iida, T. Hino, Y. Nishiyama, H. Ueda, and T. Ōshima, Bull. Chem. Soc. Jpn., 56, 3314 (1983).
2. YMC A-K03 is available from Yamamura Chemical Laboratories Co. Ltd., Kyoto, Japan.
3. E. Keinan, K. K. Seth, and R. Lamed, J. Am. Chem. Soc., 108, 3474 (1986).