

hydrolysed in acid to citronellol, providing an elegant and commercially viable route to this important perfumery intermediate.

Summary and Future Trends

These examples demonstrate that asymmetric catalysis has become a significant contributor to the "chiral economy" over the last ten years and promises to provide further developments. There is a conspicuous gap in our knowledge at the present time. Most industrial chemists think first of hydroformylation or hydrocarboxylation in the context of homogeneous catalysis, but here the problems associated with

the asymmetric induction have not been satisfactorily solved. Optical yields in rhodium hydroformylation have been uniformly low; platinum-tin complexes give better results, but under rather forcing conditions (12). Clearly much work remains to be done but the future of platinum metal complexes as asymmetric catalysts looks most encouraging, for both industrial and academic applications.

Acknowledgement

The author's own work referred to herein was supported by the Science and Engineering Research Council, using noble metal salts kindly loaned by Johnson Matthey.

References

- 1 R.H. Crabtree, *Acc. Chem. Res.*, 1979, **12**, (9), 331
- 2 B. M. Trost and T. R. Verhoeven, "Comprehensive Organometallic Chemistry", ed. G. Wilkinson, F. G. A. Stone and E. W. Abel, Pergamon, Oxford, 1982, **8**, p. 799
- 3 P. R. Auburn, P. B. Mackenzie and B. Bosnich, *J. Am. Chem. Soc.*, 1985, **107**, (7), 2033; P. B. Mackenzie, J. Whelan and B. Bosnich, *ibid.*, 1985, **107**, (7), 2046
- 4 T. Hayashi, A. Yamamoto, T. Hagihara and Y. Ito, *Tetrahedron Lett.*, 1986, **27**, (2), 191; T. Hayashi, A. Yamamoto and Y. Ito, *J. Chem. Soc., Chem. Commun.*, 1986, (14), 1090; T. Hayashi, A. Yamamoto and Y. Ito, *Chem. Lett.*, 1987, (1), 177
- 5 For a general discussion see T. Hayashi and M. Kumada, in "Asymmetric Synthesis", ed. J. D. Morrison, Academic Press, 1985, **5**, p. 147 ff.
- 6 T. Hayashi, M. Konishi, Y. Okamoto, K. Kabeta and M. Kumada, *J. Org. Chem.*, 1986, **51**, (20), 3772
- 7 H. B. Kagan and T. P. Dang, *J. Am. Chem. Soc.*, 1972, **94**, (18), 6429
- 8 C. R. Landis and J. Halpern, *J. Am. Chem. Soc.*, 1987, **109**, (6), 1746; J. M. Brown and P. J. Madrox, *J. Chem. Soc., Chem. Commun.*, 1987, in press; J. M. Brown and P. A. Chaloner, "Homogeneous Catalysis with Metal Phosphine Complexes", ed. L. H. Pignolet, Plenum Press, New York, 1983, p. 137
- 9 J. M. Brown, *Angew. Chem. Int. Ed. Engl.*, 1987, **26**, (3), 190, and references therein
- 10 (a) A. Miyashita, A. Yasuda, H. Takaya, K. Toriumi, T. Ito, T. Souchi and R. Noyori, *J. Am. Chem. Soc.*, 1980, **102**, (27), 7932; (b) T. Ikariya, Y. Ishii, H. Kawano, T. Awai, M. Saburi, S. Yoshikawa and S. Akutagawa, *J. Chem. Soc., Chem. Commun.*, 1985, (13), 922; R. Noyori, M. Ohta, Y. Hsiao, M. Kitamura, T. Ohta and H. Takaya, *J. Am. Chem. Soc.*, 1986, **108**, (22), 7117; (c) H. Takaya, T. Ohta, N. Sayo, H. Kumobayashi, S. Akutagawa, S. Inoue, I. Kasahara and R. Noyori, *J. Am. Chem. Soc.*, 1987, **109**, (5), 1596
- 11 K. Tani, T. Yamagata, S. Akutagawa, H. Kumobayashi, T. Taketomi, H. Takaya, A. Miyashita, R. Noyori and S. Otsuka, *J. Am. Chem. Soc.*, 1984, **106**, (18), 5208
- 12 G. Consiglio, P. Pino, L. I. Flowers and C. U. Pittman, *J. Chem. Soc., Chem. Commun.*, 1983, (11), 612; C. U. Pittman, Y. Kawabata and L. I. Flowers, *ibid.*, 1982, (9), 473

A Fast Response Platinum-Iridium Thermocouple

The use of thermocouples made from platinum group metals and their alloys for the measurement of high temperatures is long established and widespread, and is based upon their reproducible thermoelectric properties, their accuracy over a wide temperature range and their resistance to corrosion. Now it is possible to fabricate thin-film thermocouples using integrated circuit technology and a recent paper from the IBM Thomas J. Watson Research Center describes a process for producing thin-film platinum-iridium thermocouples

with the same thermoelectric behaviour as bulk couples (H. M. Tong, G. Arjavalingam, R. D. Haynes, G. N. Hyer and J. J. Ritsko, *Rev. Sci. Instrum.*, 1987, **58**, (5), 875-877).

The thicknesses of the platinum and iridium films were 0.51 and 0.29 μm , respectively, which ensured continuity on the alumina substrate. The thermocouple has been calibrated up to 790°C. With a fast response time and low thermal capacity the thermocouple is very suitable for monitoring instantaneous temperatures during device processing.