The use of electrochemistry in the reoxidation of Pd(0) to Pd(II), in catalytic reactions. Synthesis of chiral oxazolidin-2-ones.

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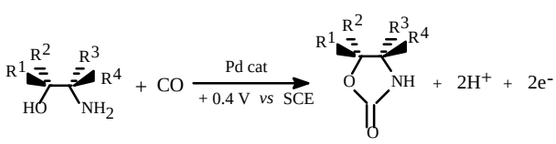
Palladium-catalyzed carbonylation represents a well established and very useful methodology in organic synthesis.[1] Although the majority of palladium-catalyzed reactions involve catalytic formation of carbonyl compounds, the same syntheses require stoichiometric quantities of the transition metal. In those reactions active Pd(II) is reduced to Pd(0). In order to obtain a catalytic system an appropriate reoxidant must be used to regenerate Pd(II). Both organic and inorganic compounds, are used as reoxidant in stoichiometric amounts: for example benzoquinone as well as $CuCl_2$.

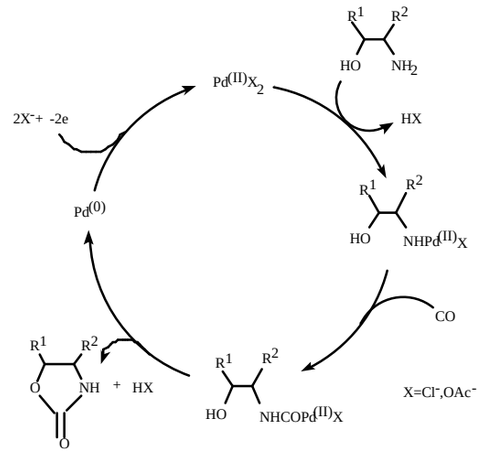
In this study, we wish to report a new procedure for the electrochemical carbonylation of 2-amino-1-alkanols to oxazolidin-2-ones; the latter are a well-known class of organic compounds, and they have many chemical and biological uses. In fact, chiral oxazolidin-2-ones (Evans' chiral auxiliaries)[2] have often been utilized as chiral auxiliaries in asymmetric synthesis and some have been found to have immunosuppressant [3] and antimicrobial activity.[4]

2-Amino-1-alkanols undergo oxidative carbonylation to give oxazolidin-2-ones, under atmospheric pressure of carbon monoxide, using a palladium(II) complex as catalyst in combination with its anodic recycling at a graphite electrode. The process is outlined in the following reaction :



The following general procedure was used: in a cell with three separated compartments, kept at 50 ± 0.1°C, the electrolysis was carried out on a solution of 2-amino-2-phenylethanol (0.5 mmol) in 0.03 dm^3 of CH_3CN containing *n*-Bu_4NBF_4 (0.2 mol dm^{-3}) as supporting electrolyte, in the presence of $Pd(OAc)_2$, (0.05 mmol) and NaOAc (2 mmol), under 1 atm of CO at +0.4 V *vs* SCE. A graphite electrode, of apparent area 3 cm^2, was used as working electrode. The counter-electrode was a Pt wire and the reference was a saturated calomel electrode (SCE). A variety of palladium complexes have been studied. It was found that the reaction efficiently proceeded under atmospheric pressure of carbon monoxide with all the catalyst systems taken into account (62-79% yields). The choice of the $Pd(OAc)_2$/NaOAc system derives from the necessity to use a chloride free system and to avoid the presence of triphenylphosphines during the work-up. The use of a base is necessary to avoid the formation of $HPd(II)^+$, that does not work in this reaction.[5] On the bases of these considerations we used this catalyst system for the reaction with various 2-amino-1-alkanols. Oxazolidin-2-ones were obtained in very good current yields (57-100%), with all the 2-amino-1-alkanols bearing a primary amino group. In the case of *N*-benzyl-2-phenyl-2-amino-1-ethanol the reaction was very slow; it was probably due to the lower reactivity of this secondary amino group versus the palladium catalyst.

The possible reaction mechanism is outlined in the following scheme:



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References.

1. Colquhoun, H. M.; Thompson, D. J.; Twigg, M. V. *Carbonylation: Direct Synthesis od Carbonyl Compounds*, 1991, Plenum Press, New York.
2. Ager, D.J.; Prakash, I.; Schaad, D.R. *Chem. Rev.* **1996**, *96*, 835-875.
3. Seki M.; Mori K. *Eur. J. Org. Chem.* **1999**, 2965-2967.
4. Seneci P.; Caspani M.; Ripamonti F.; Ciabatti R. *J. Chem. Soc., Perkin Trans I*, **1994**, 2345-2351; Barbachyn M. R., at al. *J. Med. Chem.*. **1996**, *39*, 680-695; Lohray B. B.; Baskaran S.; Srinivasa Rao B.; Yadi Reddy B.; Nageswara Rao I. *Tetrahedron Lett.* **1999**, *40*, 4855-4856.
5. Amatore, C.; Jutand, A.; Meyer, G.; Carelli, I.; Chiarotto, I. *Eur. J. Inorg. Chem.* **2000**, *8*, 1855-1859.