Atomically precise Pt-CO clusters for oxygen reduction reaction

Alberto Ventosa*, Roberto Delo Pergola*, Sandra Rondinini*, Alessandro Minguzzi*, Giancarlo Parolini*

* Dipartimento di Chimica, via Golgi 19, 20132 Milano, Italy
** Dipartimento di Scienze dell’Ambiente e delle Terre, piazza della Scienze 1, 20136 Milano, Italy
E-mail: alberto.ventosa@unimi.it

Global warming and the huge production of the greenhouse gases are very actual concerns. A new paradigm for energy production must be proposed, and in this context also the possibility to reduce the dependence on fossil fuel should be pursued. To date different solution are adopted: lithium storage, flyheels, water basins and H2 production and storage. Also metal-air batteries have been largely investigated, in recent years, as possible very attractive alternatives as energy source/storage, especially for their low environmental impact and versatility, low cost, low emissions, light weight, and relatively high specific capacity and energy density. When chemical energy is converted to electrical energy in these devices, at cathode the Oxygen Reduction Reaction (ORR) must occur at as low as possible overpotential. This ask for, a strong improvement of the ORR sluggish kinetics, about 5 orders of magnitude slower than hydrogen reaction, reducing, at the same time, the use of platinum and/or Platinum Group Metals as cathode material. In this context, Pt complexes, chosen in order to minimize the metal loading thus maintaining the same performance in term of specific activity, mA·cm⁻², and mass activity, mA·g⁻¹, as possible cathode material must be investigated. In this work, molecular metal clusters (MMC) based on Pt-CO complexes, with different CO/Cl ratios, are synthesized and electrochemically characterized for ORR in alkaline media. These complexes come back to Hm compounds [1], already studied via electrochemical measurements in acropic organic solvent to discuss the oxidation state and stability, and correlation between spectroscopic CO behaviour and electrochemical Noble modifications [2]. Moreover, very recently, the carbonyl chemical route has been largely used to prepare very active electrocatalysts, due to the possibility of tailoring the surface electrode chemical composition and the shape and size of the nanoparticles [3]. In any case, the carbonyl moieties have been used to both control the metal nanoparticles size and shape in order to mix them with other metal particles to prepare bimetallic electrocatalysts, and fix them on a suitable carbon support. The research outcomes are discussed in term of electrochemical activity, stability and durability of the prepared cathodes.