Widespread adoption of advanced energy technologies, such as proton-exchange membrane fuel cells (PEMFCs), relies on the development of efficient and durable catalysts for oxygen reduction reaction (ORR). Given its unique properties, platinum has been the primary choice for meeting activity demands, either in its pure form or as various Pt-based alloys. The challenge yet persists with catalyst degradation in the hostile environment of the PEMFC cathode. The thesis aims to explore efficient and durable Pt-based ORR catalysts prepared by the magnetron sputtering technique.

In the first chapter, Pt–Au alloys with various compositions (5, 10, 20 at.% of Au) were systematically studied to understand their composition-activity-stability relationship. It was found that $Pt_{90}Au_{10}$ exhibits the most optimal alloying, retaining the activity of Pt while effectively suppressing Pt dissolution. The stability of Pt–Au alloys was further evaluated under different simulated PEMFC operating conditions, demonstrating their higher stability compared to monometallic Pt catalyst.

In the second chapter, the composition-activity-stability relationship of ternary PtNi–Au alloys with various compositions (3, 7, 15 at.% of Au, Pt:Ni = 50:50) was investigated. It was revealed that while Au incorporation negatively impacts activity, it enhances stability. Among tested catalysts, PtNi–Au alloy with 15 at.% of gold showed the highest stability and still higher activity than monometallic Pt.

The third chapter explores the synthesis of highly porous Pt–C catalyst by electrochemical dealloying of Pt–C–CeO_x ternary compound. Pt–C catalysts exhibited significantly increased electrochemically active surface area (ECSA), enhanced ORR activity, and improved stability compared to monometallic Pt.