

Vanadium oxynitride as a novel potential anode for ammonia-fueled SOFC: electrochemical behaviour in NH_3

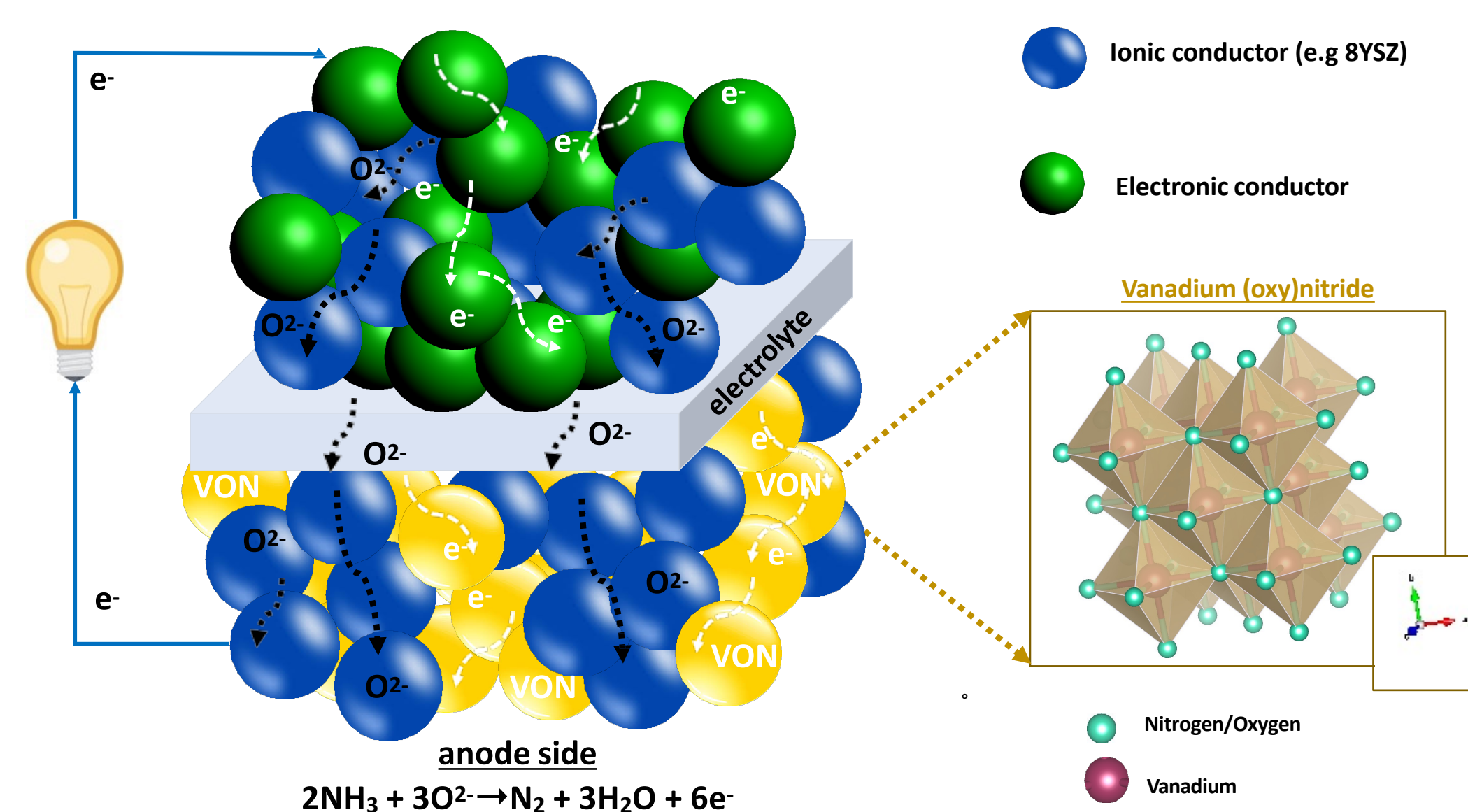
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Abstract

Ammonia (NH_3) is considered as a potential energy carrier to be used as a fuel in energy conversion devices, such as solid oxide fuel cells (SOFCs). These eco-friendly systems can directly convert chemical energy into electricity. However, a key challenge still remains for finding alternative anode materials, aiming to improve the durability and the performance of the cell components. Hence, the present work is dedicated to the synthesis and characterization of vanadium oxynitride as a potential novel rare earth-free anode for NH_3 SOFC.

Description

Ammonia is considered a promising candidate as hydrogen carrier since it has high energy density, high hydrogen content, and no emission of CO_2 during decomposition¹. For direct ammonia fuel cell, up to date, the best approach is to operate at high temperature using a SOFC since the thermal decomposition of ammonia itself occurs at temperature above 550 °C². The main challenge is the integration of redox stable anode in order to improve the durability of the anode/electrolyte interface and to achieve a good electrochemical performance³. In particular, transition metal oxynitrides, known as interstitial alloys, have been considered a fascinating class of materials due to their emerging applications as catalysts for ammonia decomposition and excellent electrical conductivity having similar properties to the platinum group metals⁴.



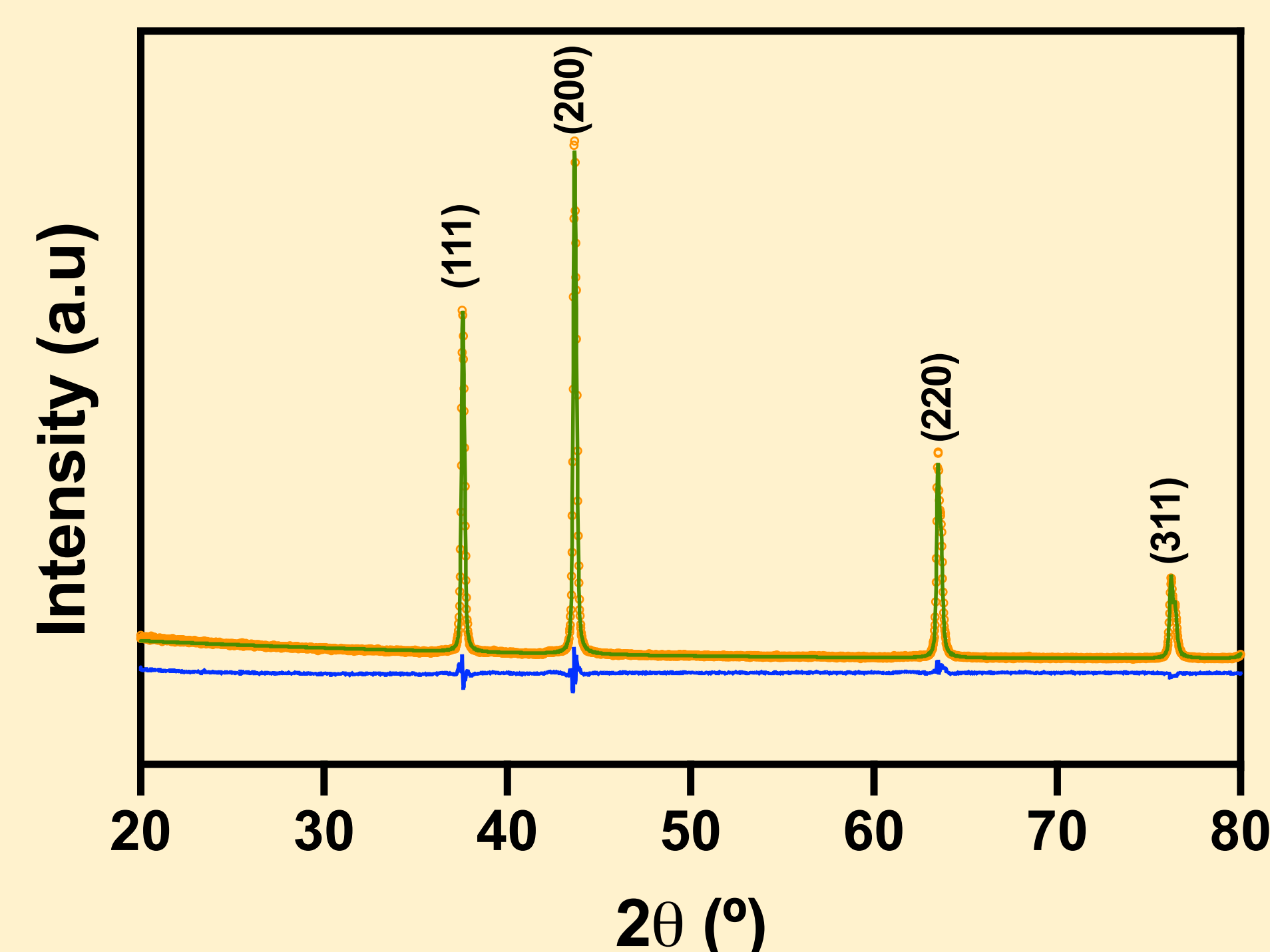
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Acknowledgments

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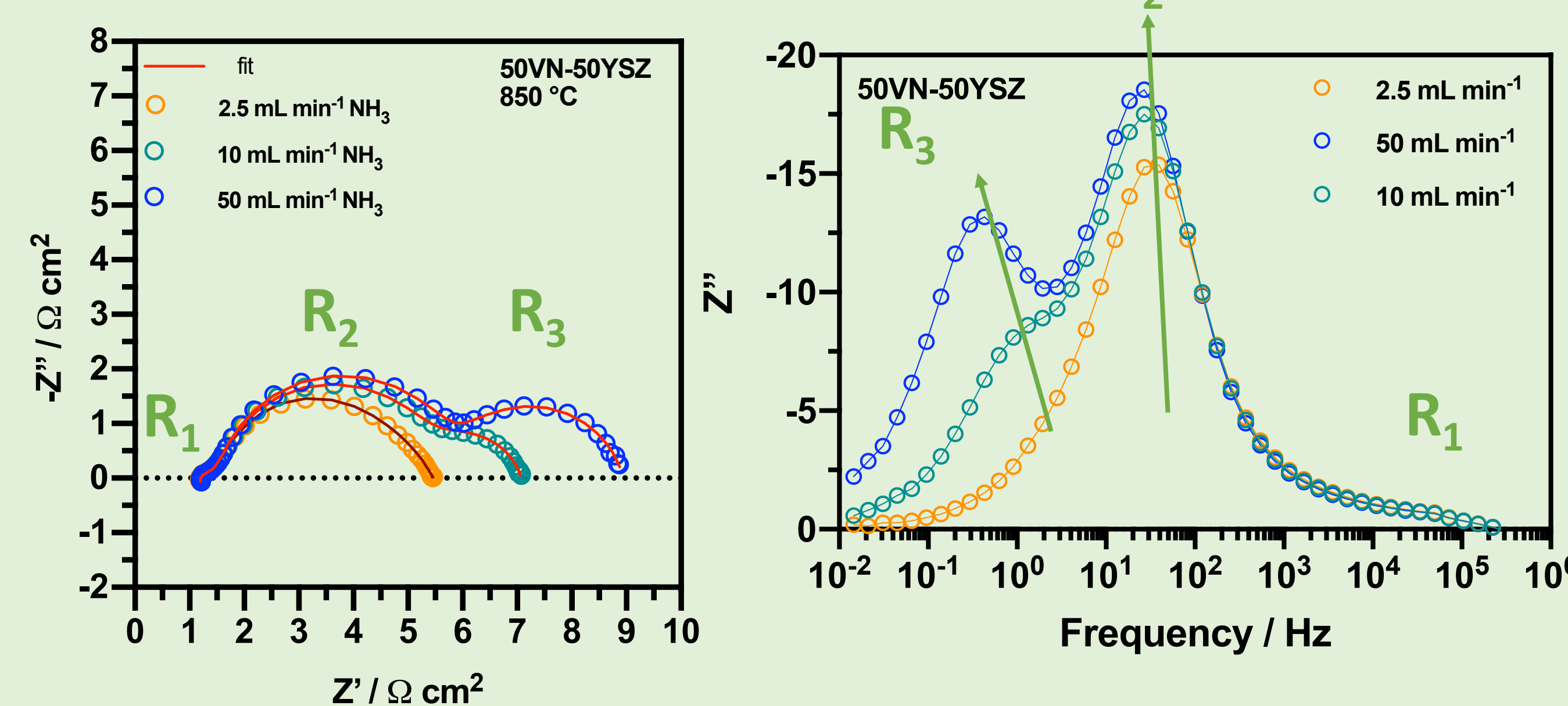
Structural characterization of VO_xN_y



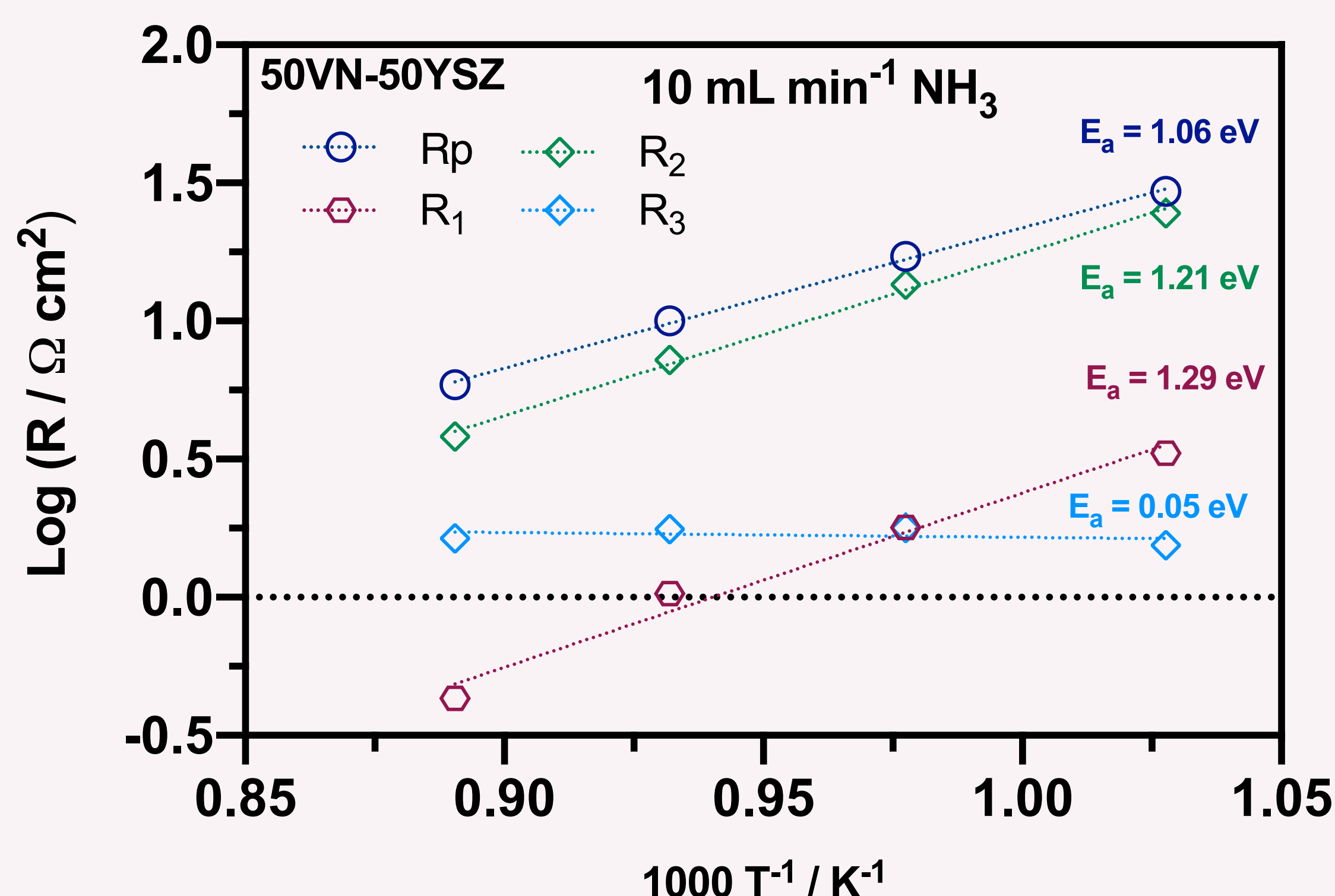
The **rock-salt layered** was confirmed by XRD refinement technique. The observed diffraction peaks) are **indexed with a cubic structure**, space group Fm3m.

Effect of ammonia flow rate in the anode electrochemical performance:

R_3 shows a **clear deviation** of the **relaxation frequency** towards lower values with increasing flow rate (**higher time constant** = process becomes **slower** with increasing flow rate)



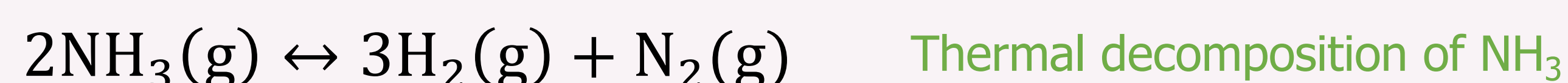
Temperature dependence of polarization resistance



- R_1 and R_2 show a strong dependence with temperature, indicating an activated process (*e.g.*, charge-transfer, surface diffusion, reaction)
- R_3 shows a negligible dependence with temperature, indicating a gas-related process (*e.g.*, gas diffusion, gas conversion)

Possible electrode processes:

R_3 - Gas conversion ($C = 10^{-2} - 10^{-1} \text{ F cm}^{-2}$)



R_2 - Charge Transfer ($C \sim 10^{-3} \text{ F cm}^{-2}$)



Reaction of H_2 at the TPBs

R_1 - Interfacial transfer ($C = 10^{-5} - 10^{-4} \text{ F cm}^{-2}$)

Interface electrode-electrolyte