The Effect of Mechanical Surface Treatment on the Optical Properties of Nanoporous Al_2O_3 Matrices with Incorporated ADP and KB5 Crystals

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INTRODUCTION

In recent papers [1, 2], the optical properties of nanoporous Al_2O_3 matrices (SmartMembranes, Germany) with the inclusion of ADP, KDP, and KB5 crystals in the pores were investigated. It was investigated that nanoporous Al_2O_3 matrices with ADP crystals embedded in the pores have a reflection coefficient of ~0.5% in the spectral range of 1-10 μm. It was shown in [1] that there is a significant diffuse scattering in the spectral range of 1-3 μm. Electron microscopic examination of the surfaces of the studied samples was also carried out. However, the reason for the low reflectance in the spectral range was not established. The present work solves these issues.

EXPERIMENT

Nanoporous matrices from SmartMembranes (Germany) and InRedox (USA) manufacturers were selected for the study. The SmartMembranes (SM) samples had a thickness of d=205μm, and the pore diameter was 40-65 nm, whereas samples from InRedox had a thickness of d=200 μm and a pore diameter of 60 nm. The ADP and KB5 crystals were embedded into the nanopores for these samples (see Table I). Sample numbers #134 - ADP: Al_2O_3, InRedox, #135 - KB5: Al_2O_3, InRedox, #136 - ADP: Al_2O_3, SM, #137 - KB5: Al_2O_3, SM. These samples were polished and polished.

TABLE I. CHARACTERISTICS OF NANOCRYSTALLINE SAMPLES

Investigated sample	Pore diameter, nm	Thickness, μm	Type of nanocrystal grown in pores	Manufacturer
134	40-65	205	ADP	InRedox
135	40-65	205	KB-5	InRedox
136	60	200	ADP	SmartMembranes
137	60	200	KB-5	SmartMembranes

In parallel, samples with ADP and KB5 inclusions were produced on the same nanoporous matrices without any interventions (without grinding and polishing). These are samples #134a - ADP: Al_2O_3, InRedox, #135a - KB5: Al_2O_3, InRedox, #136a - ADP: Al_2O_3, SM, #137a - KB5: Al_2O_3, SM.

RESULTS and DISCUSSION

Transmission and reflection spectra in the frequency range of 50-6000 cm^{-1} were measured for all the specified samples. In addition, the same spectra were measured for pure nanoporous Al_2O_3 matrices. The reflection spectra for all the listed samples are presented in Fig. 1. In addition, Fig. 2 shows the reflection spectra of samples 134a and 136a at different angles of incidence of the light beam.

Measurements of Reflection Spectra in the Optical Range

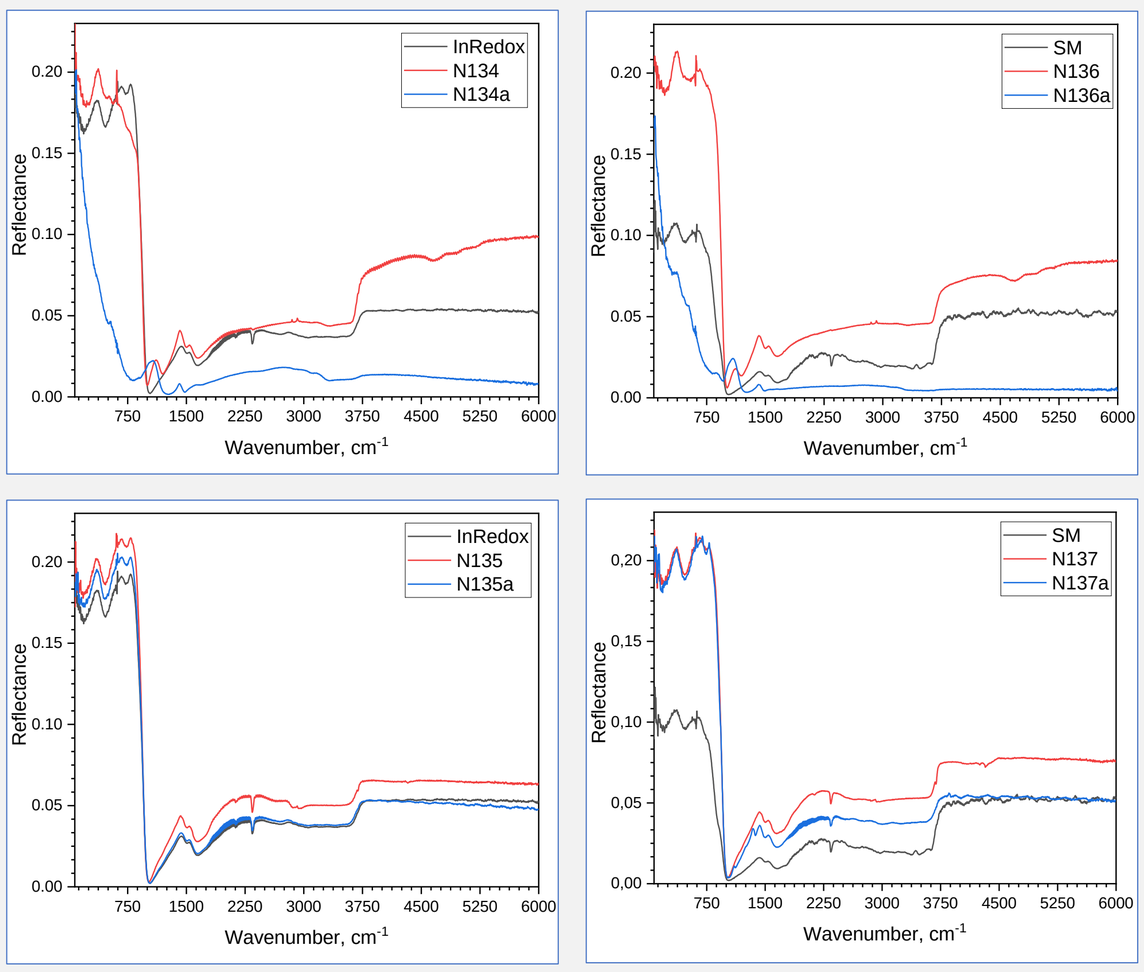

Fig. 1. Reflection spectra for samples #134-137 in the frequency range of 50-6000 cm^{-1}

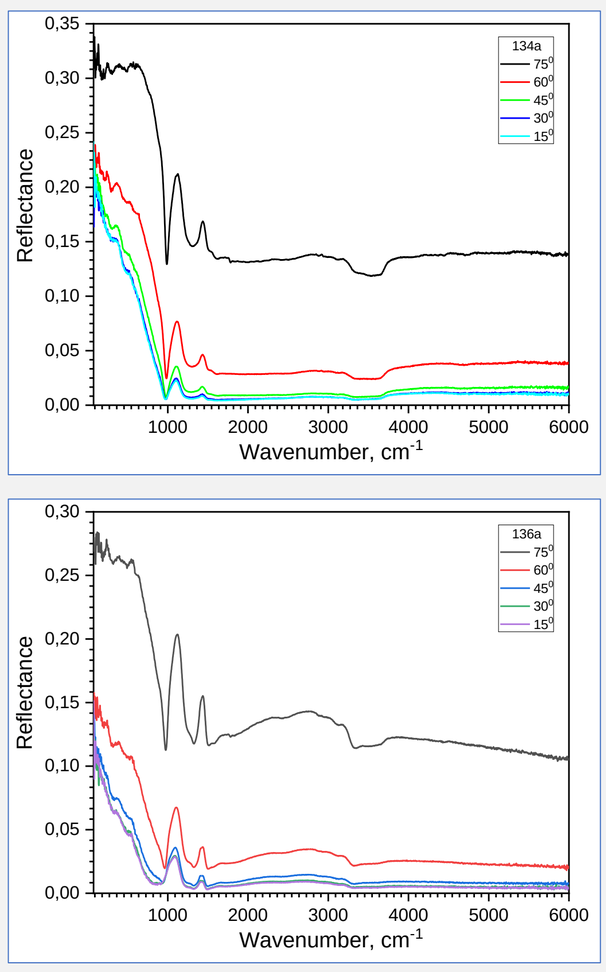

Fig. 2. Reflection spectra for samples 134a and 136a when the angle of incidence changes

Conclusion

As can be seen from Fig. 1 and Fig. 2, the surface of the nanoporous matrices, which is formed after the introduction of ADP crystals, and the angle of incidence of the light beam have a decisive influence on the reflection of nanoporous Al_2O_3 matrices with introduced ADP crystals.

References

[1] Andrushchak N., Vynnyk D., Andrushchak A., Haiduchok V., Zhydachevskyy Y. and Kushlyk M. Optical Properties of Nanoporous Al_2O_3 Matrices with Ammonium Dihydrogen Phosphate Crystals in Nanopores // 2018 IEEE 8th International Conference Nanomaterials: Application & Properties (NAP), Zatoka, Ukraine, 2018, pp. 1-4.

[2] Andrushchak N. et al. Optical and Electron Microscopy Studies of Al_2O_3 Nanomatrices with Embedded ADP and KB5 Nanocrystals // 2022 IEEE 12th International Conference Nanomaterials: Applications & Properties (NAP), Krakow, Poland, 2022, pp. NCI02-1-NCI02-4.

ACKNOWLEDGEMENT

This result of the investigation is a part of a project that has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie grant agreement No 778156 and project "Nanomatrix", funded by the Ministry of Education and Science of Ukraine (project registration number #0122U000951).