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Synthesis and catalytic ability of manganese carbonate ore/copper and cobalt oxide catalysts

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INTRODUCTION & AIM

The present study deals the preparation of manganese carbonate ore/copper and cobalt oxide-based composites and investigation of their catalytic ability for environmentally important reaction - ozone decomposition. The natural manganese carbonate ore is suitable support due to its stability and low cost.

METHOD

Preparation

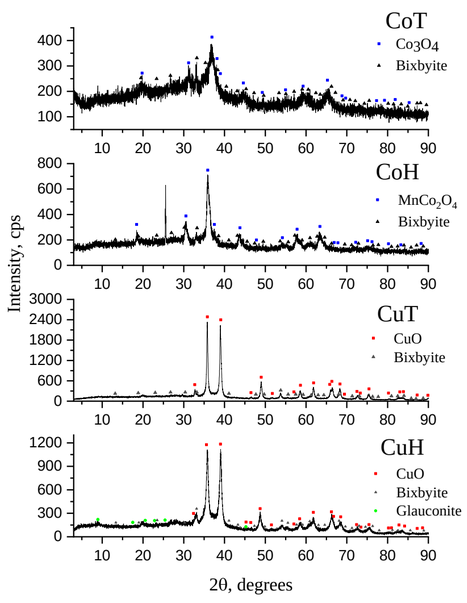
The $MnCO_3$ ore/copper and cobalt oxide-based composites were prepared using initial materials 3 g thermally treated $MnCO_3$ ore (deposit Obrochiste, Bulgaria) and 0.15M aqueous solutions of $Co(NO_3)_2.6H_2O$ or $Cu(NO_3)_2.3H_2O$ stirring for 10 minutes. The precipitant 2M NaOH was added drop by drop in the aqueous solution of nitrate precursor until pH reached 10 at continuous stirring. After precipitation the suspension was ultrasonically treated for 10 minutes and then it was stirred for one hour. The precipitate was filtered and washed with distilled water several times. The obtained precipitate was dried at 50°C and calcined at 500°C for 3 hours in air media. The obtained samples were denoted CoT and CuT.

The samples CoH and CuH were obtained as the resulting mixture from $MnCO_3$ ore and nitrate precursor (aqueous solutions of 0.15M $Co(NO_3)_2.6H_2O$ or $Cu(NO_3)_2.3H_2O$ and 2MNaOH was transferred into an autoclave at 160 °C for 8h. The so-obtained precipitates were washed and dried up in an oven, after which they were treated at 500°C for 3 hours in air media. The physicochemical characterization of the prepared composites were performed by PXRD analysis, FTIR spectroscopy, Nitrogen adsorption–desorption isotherms, BET method and SEM.

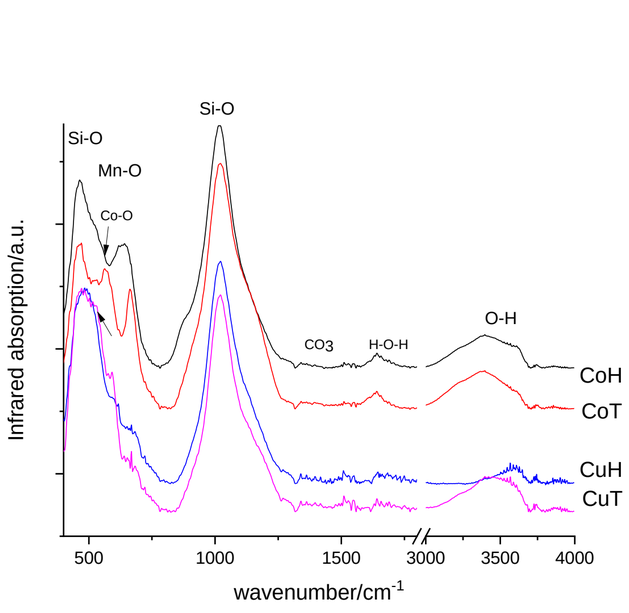
Ozone Decomposition

The ozone conversion has been studied by monitoring of change on the ozone concentration. The experiment was carried out in tubular glass reactor filled with 0.15g catalyst. The ozone concentration at the reactor inlet and outlet were measured spectrophotometrically by BMT model 964 ozone analyzer. The conversion of ozone was determined using the dependence:$((C_0–C)/C_0)x100$, where C_0 is initial concentration of ozone and C is every next concentration in the reaction for selected time interval.

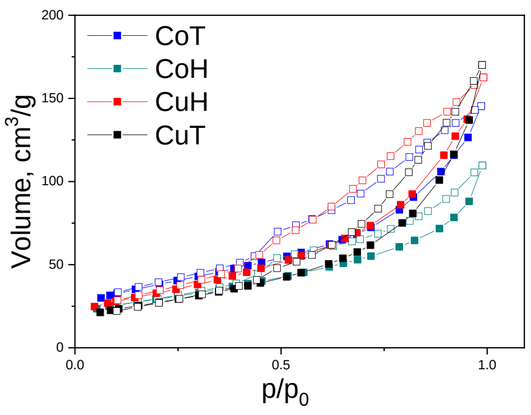
RESULTS & DISCUSSION

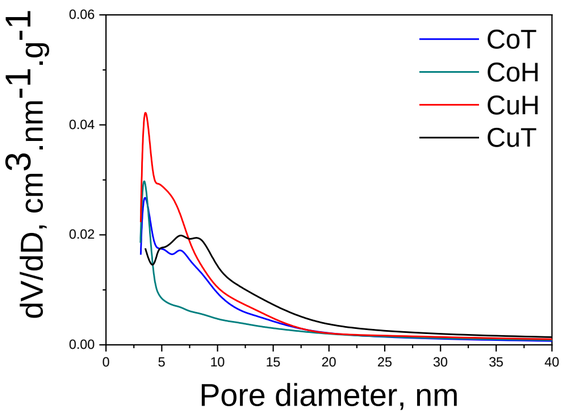


PXRD patterns of $MnCO_3$ ore/copper and cobalt oxide-based composites.



FTIR spectra of prepared $MnCO_3$ ore/copper and cobalt oxide-based composites.

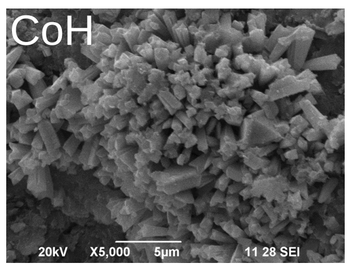


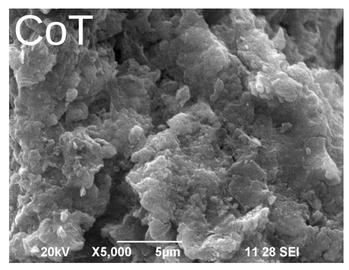


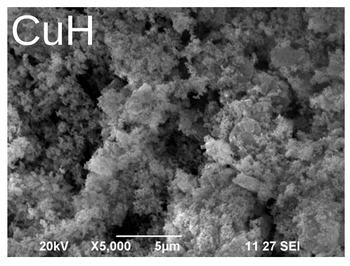
Nitrogen adsorption-desorption isotherms and pore size distribution of prepared composites.

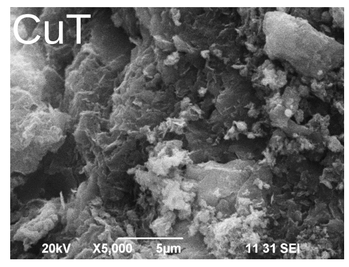
Textural characteristics of the investigated catalysts: specific surface area (S_{BET}), total pore volume (V_t) and average pore diameter (D_{av}).

Sample	S_{BET}, m^2/g	V_t, cm^3/g	D_{av}, nm
CuT	98	0.26	11
CuH	119	0.25	8.5
CoT	135	0.22	6.7
CoH	104	0.17	6.7

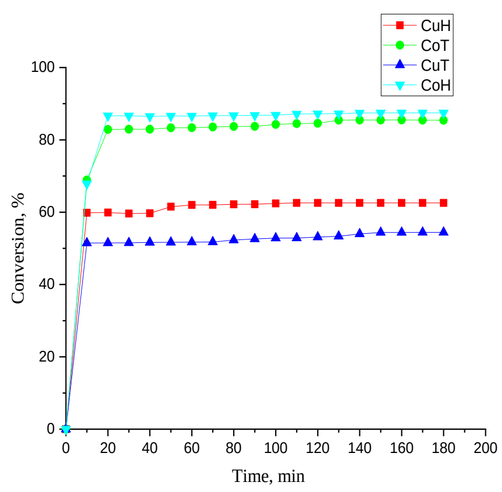








SEM images of $MnCO_3$ ore/copper and cobalt oxide-based composites.



Conversion of ozone over $MnCO_3$ ore/copper and cobalt oxide-based catalysts.

CONCLUSION

- The highest specific surface area ($135 m^2/g$) was established for thermally treated $MnCO_3$ ore/cobalt oxide in comparison with the other investigated samples.
- The prepared composites exhibit mesoporous structure.
- The average crystallite size of 10 nm for Co_3O_4 and 13-23 nm for CuO phases was determined.
- Hydrothermally treated CoH and $MnCO_3$ ore/copper oxide catalysts achieved higher ozone decomposition efficiency (87% and 63%) than thermally treated catalysts (86% and 54%).

ACKNOWLEDGMENTS

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FUTURE WORK

The use of the other natural materials for synthesis of composites and study of their catalytic activity for ozone decomposition.