Proceedings of the 2nd World Congress on Recent Advances in Nanotechnology (RAN'17)
Barcelona, Spain – April 4 – 6, 2017
Paper No. ICNEI 105
ISSN: 2371-5308
DOI: 10.11159/icnei17.105

Sub-microns NaCl-TiO2 Particles to Improve the Rain Enhancement as Cloud Seeding

Nabil El Hadri, Abdelali Zaki, Marie Vargas, Linda Zou, Mustapha Jouiad
Materials Science & Chemical Engineering, Masdar Institute of Sciences and Technology
Masdar City, PO Box 54224, Abu Dhabi
nelhadri@masdar.ac.ae; azaki@masdar.ac.ae; mbermeovargas@masdar.ac.ae; lyuanzou@masdar.ac.ae; mjouiad@masdar.ac.ae

Extended Abstract

The water scarcity in the arid region is a real concern to consider in near future. For instance, the United Arab Emirates accounts for 110 mm as the average annual rainfall, which is restricting the abundance of groundwater originating from the rainfall. Hence, there is an urgent need to look for an alternative to increase water levels to satisfy the continual growth of human and industrial needs. A promising alternative that becomes more achievable due the late technologies development is the use of cloud seeding particles to enhance the rainfall [1]. Indeed, cloud seeding is a process that allows altering the weather by the insertion of a material into the clouds in order to trigger the formation and the growth of droplets, once the water droplets are big enough they will fall due to gravity participating in the enhancement of rainfall. Basically, clouds are composed of dust particles and condensed water and the thermodynamic conditions for the formation of the droplets happened with the nucleation by aerosol particles [2]. There are two cloud seeding methods: hygroscopic cloud seeding and glaciogenic cloud seeding. In hygroscopic cloud seeding (warm clouds), it implicates the addition of salt crystals to attract water droplets and promote collision-coalescence process to form bigger droplets [3]. In glaciogenic seeding (cold clouds), it implicates the addition of particles to the cool clouds (water is below the freezing point) in order to form ice crystals, which will grow and fall. Silver iodide is used for glaciogenic cloud seeding because its form is similar to ice crystals.

In this present study, new nanomaterials were used in order to obtain a high performance for hygroscopic cloud seeding. Optimized NaCl cubic crystals with a size of 1 µm were used to prepare sub-micron NaCl/TiO_2. The NaCl/TiO_2 were evaluated by using scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction, Raman spectroscopy and water vapor sorption. SEM will be used in order to observe the shape and the size of the NaCl and NaCl/TiO_2 particles. TEM, XRD and Raman were used in order to make in evidence the presence of the TiO_2 coating on the NaCl salt crystals surface.

Figure 1 gives the SEM image of the composite crystals used in this study. They have cubic like shape.

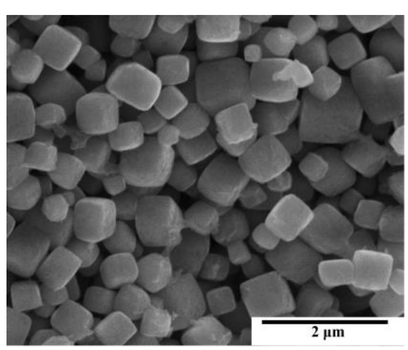

Fig. 1: SEM image of composite NaCl/TiO_2.

The XRD and Raman spectroscopy results reveal the presence of TiO_2 anatase phase. This wide band gap semiconductor (3.2 eV) is known to possess high photocatalytic properties, which is intended to increase the cloud seeding efficiency by preventing or slowing down the melting process of cloud seeds made of salt nanoparticles. Below are given bright field TEM images highlighting the presence of a thin coating layer made of TiO_2 decorating NaCl crystals (Fig. 2).

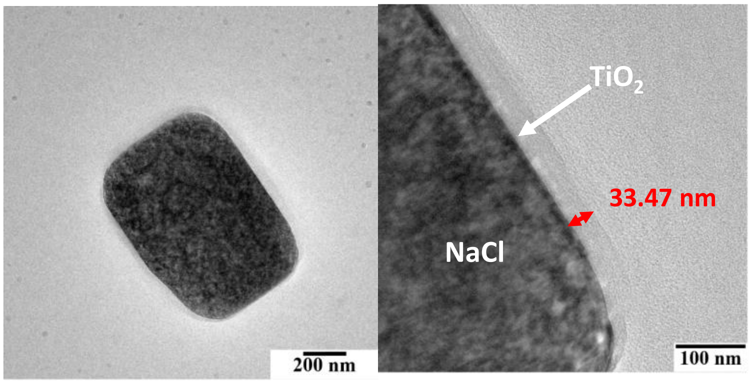

Fig. 2: Bright field TEM images of NaCl/TiO_2 composite sample.

In order to study the hydrophilicity and the water uptake of the cloud seeding particles, water vapor sorption experiments were conducted for NaCl/ 5% TiO_2 and pure NaCl. As it can be seen in figure 3, an increase of adsorbed water vapor was observed for composites compared to pure NaCl. Typically, NaCl/ 5% TiO_2 adsorbed a volume of 47.72 cm^3/g, which is 127 times higher than the one for pure NaCl having adsorption volume of 0.37 cm^3/g.

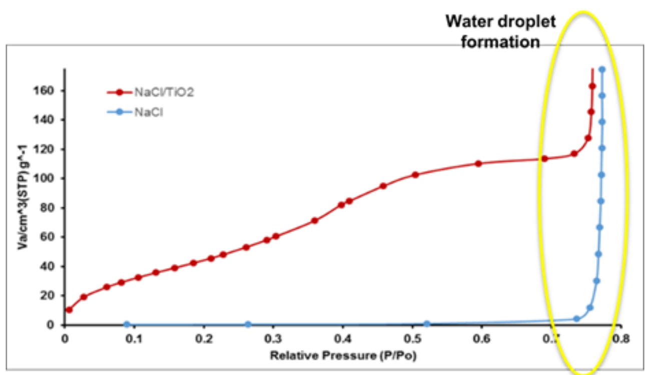

Fig. 3: Water vapor adsorption isotherms of NaCl and NaCl/TiO_2 composite sample.

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