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Mueller polarimetry characterization of sand, soil, clay and moss in visible

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We measured the complete Mueller matrices for soil (sod-podzolic soils), moss (*Ptilium crista castrensis*), sand (river sand with average dimension of grains 50 μm), all samples are from the Goloseevo Forest near Kiev, Ukraine, April 2014, and clay (white clay - Kaolin) at λ = 632.8 nm. The complete Mueller matrices for soil at different stages of moistening are measured as well. The soil moisture is estimated indirectly by time passing after sample moistening: 29, 32, 35, 38, 54, and 81 hours.

In this experiment we have used backward scattering geometry with the incidence angle 20^0, relative azimuthal angle is equal to 10^0 (0^0 means the principal plane forward scattering) and observation angles in the range 5^0-80^0. The incident laser beam was widened to 10-mm diameter to exclude the in?uence of samples surface local inhomogeneity on light scatter. The error of the Mueller matrix measurements is about 3%. To avoid potential calculation problems we investigated the reliability of the measured scattering matrices by checking that all of them satisfy the Cloude test within the experimental errors at each observation angle.

It is shown that in both cases under consideration the eight matrix elements m_{13}, m_{14}, m_{23}, m_{24}, m_{31}, m_{32}, m_{41} and m_{42} are zero within the experimental errors over the entire observation angle range and, thus, the Mueller matrix has a block-diagonal structure. The elements m_{22}, m_{33}, and m_{44} are most sensitive as for all four samples identification, as for soil moisture estimation. The element m_{11} is highly sensitive to identify clay, sand and pair of soil and moss. The elements m_{34} and m_{43} show inverse behavior: both of them are highly sensitive for soil and moss. Whereas clay and sand cannot be identified basing on these matrix elements. Using the dependences of matrix elements on observation angles the stages of drying 29, 32, 35 and 38 hours can not be distinguished, whereas times 54 and 81 hours differ considerably as between each other as from previous stages of drying.

After measuring the Mueller matrices the parameters characterizing depolarization (the depolarization index, $Q(\mathrm{M})$-metrics, Lorentz depolarization indices and Lorentz and Cloude entropy) and anisotropy (values and azimuths of phase and amplitude anisotropy) properties of the samples have been calculated to establish the potential for samples identification. It turns that all depolarization metrics are sensitive in both cases under consideration: for samples identification and for estimations of the stages of drying 54 and 81 hours between themselves and from the previous stages. At that, maximum sensitivity is shown by $Q(\mathrm{M})$-metrics.