



## **Fractal properties and aggregation phenomena of humic acids studied by electron transmission microscopy**

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Transmission electron microscopy (TEM) image analysis has been applied to the evaluation of the fractal dimensions and aggregation mechanisms of soil and peat humic acids (HAs) in aqueous solutions at realistically small concentration and at various pH values and equilibration times. TEM image analysis based on fractal concepts and the determination of fractal dimensions suggest a cluster-cluster aggregation mechanism for HAs in any condition examined. At pH=3, HA clusters exhibit relatively compact structures characterized by time-dependent values of the fractal dimension which are consistent with an underlying diffusion limited aggregation (DLA) mechanism controlled by the diffusion of aggregates, which is predominant in any condition. At pH=6, the HA aggregates at short times are characterized by open, elongated structures that become larger and more compact with increasing the equilibration time, and feature fractal dimension values consistent with a reaction limited aggregation (RLA) mechanism. The aggregate chemical reactivity, which is controlled by the solution pH affecting the electrostatic charge of HAs, plays an important role in this mechanism.