Surface properties of sol particles

I. Dependence of peptizability of flocculated sols on the aging time

S. Rohrsetzer and F. Csempesz

With 5 figures and 3 tables

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Introduction

The peptizability of flocculated sols depends on the chemical nature of the sol and on the conditions under which the sol was flocculated and the coagulum was peptized. Both the structure of the flocs formed during flocculation (i.e. whether they are loose or compact) and the rate of subsequent aging processes have a great influence. As far as the peptiza-
tion is concerned, the value of the repulsive potential due to the overlapping of the elec-
trical double layer is of primary importance.

According to the experimental investiga-
tions and theoretical considerations of Frens
and Overbeek (1, 2), flocs of electrocratic sols
can be peptized only if there is no recrystalliza-
tion of the particles before peptization takes
place. If the repulsive potential is high enough,
a well defined time period, characteristic of
a given sol, can be observed within which the
flocs can be repeptized. This is due to the fact
that the adsorbed ions and water molecules
on the surface may prevent a direct contact of
the surfaces for a certain time.

Nevertheless, if particles are involved that
have inhomogeneous surfaces, a direct contact
along small regions may occur immediately after flocculation, and in this case the rate of recrystallization is the predominant factor of
peptizability.

Results of careful investigations carried out
by Benitez and Mac Ritchie (3) confirm the
earlier observation that the peptizability of
flocs is not independent of the chemical nature
of the sols from which the flocs had been
formed.

Our previous results obtained with iron
hydroxide sols (4) have shown that if the pep-
tizability is dependent on recrystallization, it is
affected by factors other than those influencing
the deflocculation. We found that the peptiz-
ability of flocs increases with increasing concen-
tration of the flocculating electrolyte and the
size of the counterion.

This result is in a good agreement with the
theoretical conclusions of Frens and Overbeek because the smallest distance to which particles
may approach each other depends also on the
size of the counterions.

Preparation of sols

Prussian blue sol was prepared by adding
FeCl₃ solution to K₄Fe(CN)₆ solution.
Tin hydroxide sol was obtained by peptizing
Sn(OH)₄ suspension with NaOH.
Aluminium hydroxide sol was prepared by
peptizing Al(OH)₃ suspension with AlCl₃
solution at 60°C.
Iron(III)hydroxide sol was obtained by using
Graham’s method.
Arsenic trisulphide sol was prepared by allow-
ing H₂S gas to react with saturated As₂O₃
solution.
Silver iodide sol: AgNO₃ solution (10⁻² mol/l)
was added to KI solution of the same concen-
tration by quickly pouring the solutions into
each other.

The sols were dialysed except for silver
iodide which was prepared freshly in every
case.
Determination of the equivalent radius of sol particles

The particle radius was determined by using both the ultracentrifuge and the BET method. The sedimentation constant was calculated from the experimental data of centrifuging whereas the mean particle radius was calculated using the Stokes equation. In order to measure the specific surface area the sols were dried at room temperature and evacuated. Specific surface areas were measured by a BETograph instrument.

Flocculation and peptization of sols

The purpose of the present investigations was to find correlations between the peptizability of the flocs of various sols and their recrystallization. Therefore, sols were flocculated in such a manner that the surface charge as well as the amount of adsorbed ions be at minimum. Sols were flocculated by the electrolyte which was able to neutralize by chemical reaction the potential determining ion. The compound formed in these reactions has the same chemical composition as the particles themselves, except for the arsenic trisulphide sol (table 1).

The electrolyte concentration resulting in a maximum sedimentation rate of flocs was chosen as flocculation value. At this electrolyte concentration the surface charge is at minimum, as indicated by the maximum value of sediment volume.

Flocs were aged for different time periods and then mixed with a peptizer of increasing concentration. The mixture was rotated for an hour at 25 °C, then centrifuged for 20 minutes at a centrifugal acceleration of $2 \cdot 10^6$ cm s$^{-2}$. The peptizability of sols ($P\%$) was calculated from the concentration of the peptized sol, taking into account the peptizer amount added previously to the mixture:

$$P(\%) = \frac{\text{concentration of peptized sol}}{\text{concentration of initial sol}} \cdot 100$$

Concentration values of peptizers belonging to the 50% degree of peptization ($c_{p-50}$) and increases of these values after various aging periods were established from the peptization curves.

Experimental results

Peptization curves of flocs of various sols are shown in figures 1–5. Results concerning arsenic trisulphide sols are not shown in this

![Fig. 1. Peptizability of Prussian blue sols's flocs after different aging times](image)

Table 1. Some characteristics of the sols

<table>
<thead>
<tr>
<th>Sols</th>
<th>Conc. of sols %</th>
<th>Stabilizing electrolyte</th>
<th>Flocculating electrolyte</th>
<th>Flocc. value mmol/l</th>
<th>Particle radius (Å) from sediment. const.</th>
<th>spec. surf. area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prussian blue Tin</td>
<td>0,44</td>
<td>$K_4Fe(CN)_6$</td>
<td>$FeCl_3$</td>
<td>1,00</td>
<td>45</td>
<td>57</td>
</tr>
<tr>
<td>Tin hydroxide</td>
<td>0,28</td>
<td>$Na_2SnO_3$</td>
<td>$HCl$</td>
<td>2,45</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Aluminium hydroxide</td>
<td>0,22</td>
<td>$AlCl_3$</td>
<td>$NH_4OH$</td>
<td>6,95</td>
<td>130</td>
<td>160</td>
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<tr>
<td>Iron hydroxide</td>
<td>0,30</td>
<td>$FeCl_3$</td>
<td>$NH_4OH$</td>
<td>3,35</td>
<td>35</td>
<td>32</td>
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<tr>
<td>Silver iodide</td>
<td>0,12</td>
<td>$KI$</td>
<td>$AgNO_3$</td>
<td>0,45</td>
<td>240</td>
<td>4100</td>
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<tr>
<td>Arsenic trisulphide</td>
<td>0,21</td>
<td>$H_3AsO_3$</td>
<td>$CaCl_2$</td>
<td>3,90</td>
<td>74</td>
<td>960</td>
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</tbody>
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