MSE-401

Composite Materials

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Sol-Gel Method:

- The sol gel process is basically a formation of a stable colloidal solution called **sol**.
- The sol is a liquid suspension of solid particles ranging in size from 1 nm to 1 micron.
- It can be obtained by hydrolysis and partial condensation of precursors such as an inorganic salt or a metal alkoxide. The further condensation of sol particles into a three-dimensional network produces a **gel** material.
- The gel is a diphasic material in which the solids encapsulate the solvent.
- The molecular weight of the oxide species produced continuously increases. The materials are referred to as aqua

sol or aqua gels when water is used as a solvent and aquo sol or alcogel when alcohol is used.

- The encapsulated liquid can be removed from a gel by either evaporative drying or with supercritical drying /extraction.
- The resulting solid products are known as **xerogel** and **aerogel**, respectively.
- When gels are dried by evaporation, the dried product is called **xerogel**.
- When the gels are dried by supercritical drying, the dried gel is called **aerogels**.
- The aerogel retains high porosity and has very high pore volume.

Therefore the sol-gel process is a wet-chemical technique that uses either a chemical solution (sol short for solution) or colloidal particles (sol for nanoscale particle) to produce an integrated

network (gel). Metal alkoxides and metal chlorides are typical precursors. They undergo hydrolysis and polycondensation reactions to form a colloid, a system composed of nanoparticles dispersed in a solvent. The sol evolves then towards the formation of an inorganic continuous network containing a liquid phase (gel). Formation of a metal oxide involves connecting the metal centers with oxo (M-O-M) or hydroxo (M-OH-M) bridges, therefore generating metal-oxo or metal-hydroxo polymers in solution. After a drying process, the liquid phase is removed from the gel. Then, a thermal treatment (calcination) may be performed in order to favor further polycondensation and enhance mechanical properties.

The general scheme of preparation by sol gel method is shown in **Figure. 1**

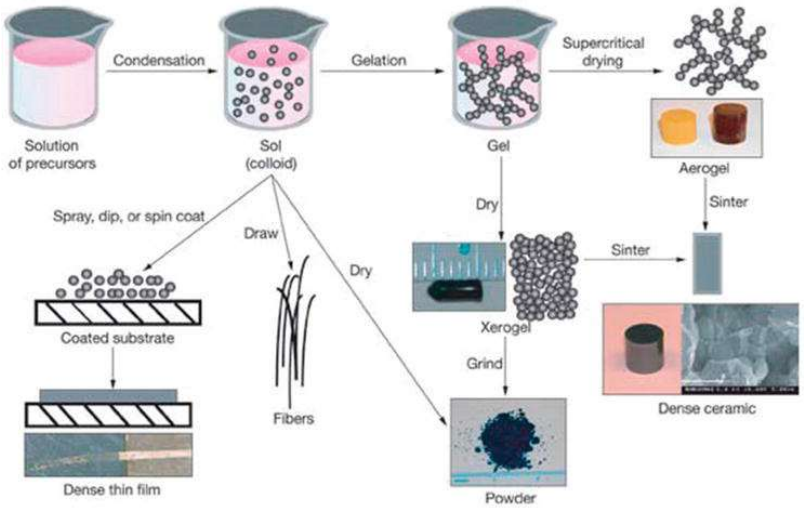

Figure 1: Schematic diagram of Sol-Gel Method

Aguilar, G. V. Introductory Chapter: A Brief Semblance of the Sol-Gel Method in Research. In: Aguilar, G. V., editor. Sol-Gel Method - Design and Synthesis of New Materials with Interesting Physical, Chemical and Biological Properties [Internet]. London: Intech Open; 2018 [cited 2022 Sep 13]. Available from: https://www.intechopen.com/chapters/64744, doi: 10.5772/intechopen.82487