Sol-gel Method

It is wet chemical technique, also known as chemical solution deposition.

It is a bottom up approach.

Precursors: MOR

MCl

$Si(OEt)_4$-Tetra Ethyl Orthosilicate(TEOS)

Reactions

a) Hydrolysis $MOR+H_2O \rightarrow MOH+ROH$

b) Condensation $MOH+ROM \rightarrow MOM+ROH$

Stage1: Formation of Sol(Colloidal Suspension)

Sol is obtained from desired precursors and H_2O or dilute acids.

Stage2: Formation of gel:

Polycondensation reaction increases the viscosity of the sol, particles join to form a network, forming gel.

Stage3: Syneresis (Aging process of gel):

Polycondensation reaction continues until the gel transforms into a solid mass, accompanied by contraction of the gel network and expulsion of solvent from gel pores.

There could be phase transformations.

Aging can exceed 7 days and is critical in prevention of cracks.

Stage4: Drying:

Water and other volatile liquids are removed from the gel network.

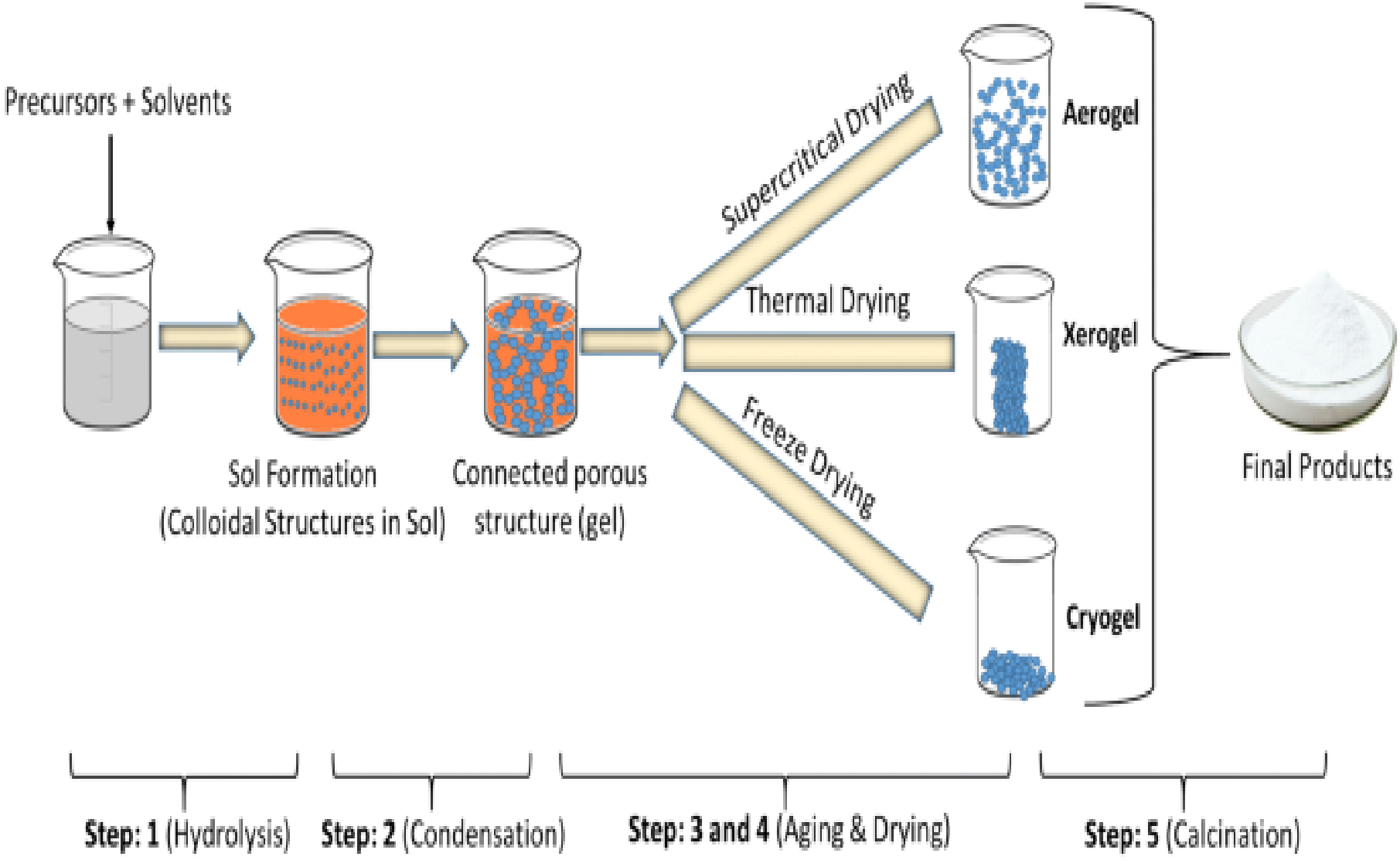
This process is complicated due to fundamental changes in the structure of the gel.

Stage5: Calcination:

Surface bound M-OH groups are eliminated by dehydration, by heating up to 800^0C and stabilized against rehydration.

Stage6: Densification of gel:

Gel is heated at high temperature (greater than 800^0C), therefore the pores of the gel network are collapsed and remaining organic species are volatilized.


Precursors + Solvents
Sol Formation
(Colloidal Structures in Sol)
Connected porous
structure (gel)
Supercritical Drying
Thermal Drying
Freeze Drying
Aerogel
Xerogel
Cryogel
Final Products
Step: 1 (Hydrolysis)
Step: 2 (Condensation)
Step: 3 and 4 (Aging & Drying)
Step: 5 (Calcination)

APPLICATIONS

1.For the synthesis of non metallic inorganic materials, like glass, ceramics.

2. For the synthesis of metal oxides ($Si0_2$, $Ti0_2$)

ADVANTAGES

1. It is cheap
2. Low temperature technique.
3. Chemical composition of the product can be controlled
4. Produce high purity products
5. Small quantities of dopants such as organic dyes, and rare earth metals can be introduced in the sol and end up in the final product finely dispersed.
6. Simple and effective.

LIMITATION

1. Production rate is low.