NASA TECH BRIEF
Marshall Space Flight Center

High Strength High Modulus Ceramic Fiber

The problem:

A low cost method is needed to develop a high-strength, high modulus, continuous ceramic oxide fiber.

The solution:

A general process of making fibers has been developed which will transform inexpensive metallic salts into syrup-like liquids that can be fiberized at room temperatures. The resulting "salt" fibers are then converted to oxides by calcination at relatively low temperatures.

How it's done:

The production of this ceramic oxide filament, can be divided into five unit operations:

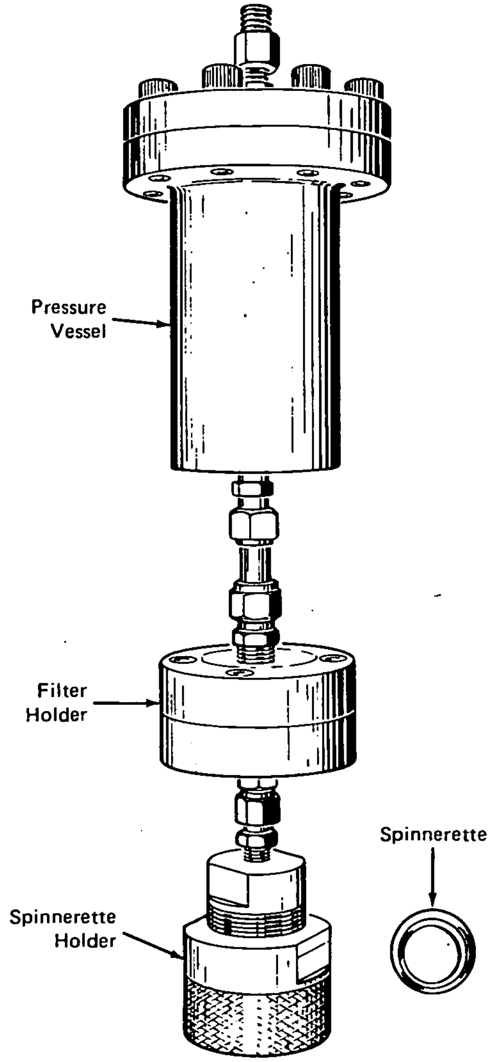
1. Solution preparation
2. Fiber formation
3. Fiber collection
4. Fiber drying
5. Calcination to oxide form.

The fiberizable salt solution is prepared by adding aluminum metal to be an inorganic acid salt solution. Upon heating the mixture, a rapid exothermic reaction occurs in which aluminum is dissolved and hydrogen gas is liberated according to the following equation:

$$2Al + 6H_3O^+ \rightarrow 2Al^{3+} + 3H_2 + 6H_2O$$

When the rate of aluminum dissolution slows down, the undissolved aluminum is removed by screening. The solution is then further heated to evaporate excess water and to obtain the desired viscosity and solid content. At this point, the salt solution is clear and colorless. Acetic acid is then added for stabilization.

The salt solution is next transformed into monofilaments by using a room temperature extrusion apparatus as shown in the figure. The pressure vessel is filled with the fiberizable solution, and pressure is applied to the system through the fitting. The pressure is varied



Stainless Steel Pressure Extrusion System Used for Producing Monofilament Fiber

(continued overleaf)

between 0-1825 kN/m^2 (0-250 psig) using compressed nitrogen gas. The fiberizable solution is pushed through an in-line high pressure filter holder. After filtration, the solution proceeds to the spinnerette holder where it is pressure extruded. The raw fiber produced is allowed to fall to a collector below the nozzle. After falling about 15 feet it is picked up on the drum. This drum, rotated by a precision speed control motor, is used to collect the extruded fiber. The fibers are then ready for calcination after having been removed from the drum and placed in an electrical resistance furnace equipped with silicon carbide elements at room temperature. They are then heated slowly to approximately 922 K (1200°F). The heating rate is then increased until a maximum temperature of 1283 K (1850°F) is reached. The furnace is held at this temperature for 20 minutes. The calcinated fiber is removed from the furnace and stored in plastic boxes to await testing and evaluation.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
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Reference: B72-10592

Patent status:

NASA has decided not to apply for a patent.

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