

Materials List for

# Methane Hydrate Crystallization on Sessile Water Droplets

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## Citation

Johnson, A.M., Zhao, Y., Kim, J., Dai, S., Glass, J.B. Methane Hydrate Crystallization on Sessile Water Droplets. *J. Vis. Exp.* (171), e62686, doi:10.3791/62686 (2021).

## Date Published

May 26, 2021

## DOI

10.3791/62686

## URL

jove.com/video/62686

## Materials

| Name  | Company               | Catalog Number                     | Comments  |
|---|-----------------------|------------------------------------|---|
| <b>CAMERA AND LAPTOP</b>                                  |                       |                                    |   |
| Camera Body   | Nikon                 | D7200                              | Name in Protocol: camera  |
| Camera Control Pro 2 Software                             | Nikon                 |                                    | Name in Protocol: camera software   |
| Laptop  | HP Pavilion           | hp-pavilion-laptop-14-ce0068st     | Needs to be PC with plenty of storage (~ 1 Tb)<br>Name in Protocol: laptop  |
| Macrophotography Lens                                     | Nikon                 | AF-S MICRO 105mm f/2.8G IF-ED Lens | Name in Protocol: lens  |
| <b>CONSUMABLES</b>  |                       |                                    |   |
| Deionized water   |                       |                                    | Name in Protocol: DI water  |
| Dry Ice   | VWR or grocery store  |                                    | Buy just before nucleation<br>Name in Protocol: dry ice   |
| Ethanol   |                       |                                    | Name in Protocol: ethanol   |
| Ethylene Glycol   |                       |                                    | Name in Protocol: ethylene glycol   |
| <b>COOLING SYSTEM</b>                                     |                       |                                    |   |
| 1/2 in. O.D. x 3/8 in. I.D. x 25 ft. Polyethylene Tubing  | Everbilt              | Model # 301844                     | For circulating coolant from chiller to copper coils in aquarium<br>Name in Protocol: 3/8" (inner diameter) plastic tubing                    |
| Circulating chiller                                       | Polyscience           |                                    | Name in Protocol: chiller   |
| Economical Flexible Polyethylene Foam Pipe Insulation     | McMaster-Carr         | 4530K162                           | 3/4" thick wall; 1/2" inner diameter; R Value 3; 6' long<br>Name in Protocol: foam pipe insulation  |
| Plastic tubing  |                       |                                    | use any tubing that fits the airline connection in the lab and long enough to travel from the airline connection to the front of the aquarium |
| <b>DATALOGGER</b>   |                       |                                    |   |
| Armature Multiplexer Module for 34970A/34972A, 20-Channel | Keysight Technologies | 34901A                             | Name in Protocol: datalogger multichannel   |

|  |                           |                   |   |
|--|---------------------------|-------------------|---|
| Benchvue or Benchlink software   | Benchvue or Benchlink     |                   | Name in Protocol: temperature transducer software   |
| Data Acquisition/Switch Unit. GPIB, RS232  | Keysight Technologies     | 34970A            | Name in Protocol: datalogger  |
| USB/GPIB interface   | Keysight Technologies     | 82357B            | Name in Protocol: datalogger USB  |
| datalogger multichannel  |                           |                   |   |
| Schott Fostec -Llc 20510 Ace Fiber Optic Light Source  | Schott Fostec             | A20500            | 3115PS-12W-B20 115 V ~AC 50/60Hz 5/4.5 W<br>Name in Protocol: light source unit   |
| Schott Fostec light source guide - single bundle   | Schott Fostec             | A08031.40         | Name in Protocol: fiber optic light source cable  |
| <b>METHANE GAS AND REGULATOR</b>   |                           |                   |   |
| 1/4 OD in. x 20 ft. Copper Soft Refrigeration Coil   | Everbilt                  | Model # D 04020PS | For pressurizing ISCO pressure pump. An additional pack is needed for coolant circulation, as listed below.<br>Name in Protocol: high pressure-rated 1/4" copper pipe |
| Methane cylinder regulator   | Airgas                    | Y11N114G350-AG    | Name in Protocol: methane cylinder regulator  |
| Methane gas cylinder   | Airgas                    | ME UHP300         | Name in Protocol: methane gas cylinder  |
| <b>PRESSURE PUMP</b>   |                           |                   |   |
| 1/4 in. flexible tubing, ~ 3 ft.   |                           |                   | Connect to pump inlet for leak test<br>Name in Protocol: 1/4" flexible tubing   |
| 260D Syringe Pump W/Controller   | Teledyne Instruments Inc. | 67-1240-520       | Name in Protocol: pressure pump   |
| Controller – Ethernet/USB  | Teledyne Instruments Inc. | 62-1240-114       | Purchase if you would like to install Labview onto computer and control pressure pump remotely. We did not do this.   |
| Smooth-Bore Seamless 316 Stainless Steel Tubing, 1/4" OD, 0.035" Wall Thickness, 1 Foot Long (x5)                            | McMaster-Carr             | 89785K824         | Name in Protocol: 1/4" pipe   |
| Smooth-Bore Seamless 316 Stainless Steel Tubing, 1/8" OD, 0.02" Wall Thickness, 1 Foot Long (x4)                             | McMaster-Carr             | 89785K811         | Name in Protocol: 1/8" pipe   |
| Stainless Steel Swagelok Tube Fitting, Reducing Union, 1/4 in. x 1/8 in. Tube OD (x4)  | Swagelok                  | SS-400-6-2        | Name in Protocol: 1/8" to 1/4" adapter  |
| <b>PRESSURE CELL</b>   |                           |                   |   |
| 316 Stainless Steel Nut and Ferrule Set (1 Nut/1 Front Ferrule/1 Back Ferrule) for 1/4 in. Tube Fitting (20)                 | Swagelok                  | SS-400-NFSET      | Used for fitting connections where necessary<br>Name in Protocol: ferrule set   |
| 316L Stainless Steel Convoluted (FM) Hose, 1/4 in., 316L Stainless Steel Braid, 1/4 in. Tube Adapters, 60 in. (1.5 m) Length | Swagelok                  | SS-FM4TA4TA4-60   | Connects pressure pump to pressure cell<br>Name in Protocol: 1/4" braided stainless steel flexible pressure-rated hose  |
| ABAQUS   | ABAQUS FEA                |                   | Name in Protocol: simulation software   |
| Abrasion-Resistant Cushioning Washer for 7/8" Screw Size, 0.875" ID, 2.25" OD, packs of 10 (x1)                              | McMaster-Carr             | 90131A107         | Name in Protocol: 2.25" rubber washer   |
| Abrasion-Resistant Sealing Washer, Aramid Fabric/Buna-N Rubber, 3/8" Screw Size, 0.625" OD, packs of 10 (x1)                 | McMaster-Carr             | 93303A105         | Used for illumination port  |

|   |  |   |   |
|---|--|---|---|
| Acrylic Sheet   White 2447 / WRT31 Extruded Paper-Masked (Translucent 55% (0.118 x 12 x 12)                           | Interstate Plastics                        | ACRW7EPSH   | Machine a circle of acrylic to fit in the inner chamber of the pressure cell to serve as the background for imaging<br>Name in Protocol: acrylic disc |
| AutoCAD   | AutoCAD                                    |   | Name in Protocol: engineering design software   |
| Conax fitting   | Conax Technologies                         | 311401-011  | TG(PTM2)-24-A6-T, OPTIONAL 1/4" NPT<br>Name in Protocol: pressure seal connector  |
| High Accuracy Oil Filled Pressure Transducers/Transmitters for General industrial applications (x2)                   | Omega Engineering, Inc.                    | PX409-3.5KGUSBH   | Buy two so there is a backup.<br>Name in Protocol: pressure transducer  |
| HIGH PRESSURE CHAMBER PARTS   | Wither Tool, Die and Manufacturing Company |   | Machining for pressure cell parts as listed in CAD drawings (Figure S1)<br>Name in Protocol: Part B = stainless steel washer                          |
| High-Strength 316 Stainless Steel Socket Head Screw, M5 x 0.80 mm Thread, 14 mm Long (x20)                            | McMaster-Carr                              | 90037A119   | Used for illumination port  |
| High-Strength 316 Stainless Steel Socket Head Screw, M8 x 1.25 mm Thread, 25 mm Long (x20)                            | McMaster-Carr                              | 90037A133   | Name in Protocol: M8 stainless steel screws   |
| Oil-Resistant Hard Buna-N O-Ring, 3/32 Fractional Width, Dash Number 120, packs of 50 (x1)                            | McMaster-Carr                              | 5308T178  | Name in Protocol: 1" o-ring   |
| Oil-Resistant Hard Buna-N O-Ring, 3/32 Fractional Width, Dash Number 128, packs of 50 (x1)                            | McMaster-Carr                              | 5308T186  | Name in Protocol: 1.5" o-ring   |
| Omega Inc. pressure transducer software   | Omega Engineering, Inc.                    |   | Name in Protocol: pressure transducer software  |
| Polycarbonate Disc  | McMaster-Carr                              | 8571K31   | Listed in CAD drawings for illumination port, Fig. S1 Part E  |
| Sapphire windows (x3)   | Guild Optical Associates, Inc.             | Optical Grade Sapphire Window, C-Plane<br>Diameter: 1.811" ±.005"<br>Thickness: .590" ±.005"<br>Surface Quality: 60/40<br>Edges ground and safety chamfered | Buy three so there are two backups.<br>Name in Protocol: sapphire window  |
| Solid Thermocouple Wire FEP Insulation and Jacket, Type K, 24 Gauge, 50 ft. Length (x1)                               | McMaster-Carr                              | 3870K32   | Name in Protocol: thermocouples   |
| Stainless Steel Integral Bonnet Needle Valve, 0.37 Cv, 1/4 in. Swagelok Tube Fitting, Regulating Stem (x4)            | Swagelok                                   | SS-1RS4   | Two will be used for the pressure pump as well.<br>Name in Protocol: 1/4" needle valves   |
| Stainless Steel Pipe Fitting, Hex Nipple, 1/4 in. Male NPT (x2)   | Swagelok                                   | SS-4-HN   | Used for illumination port  |
| Stainless Steel Swagelok Tube Fitting, Female Branch Tee, 1/4 in. Tube OD x 1/4 in. Tube OD x 1/4 in. Female NPT (x2) | Swagelok                                   | SS-400-3-4TTF   | Used with pressure transducer<br>Name in Protocol: branch tee fitting   |
| Stainless Steel Swagelok Tube Fitting, Male Connector, 1/4 in. Tube OD x 1/4 in. Male NPT (x4)                        | Swagelok                                   | SS-400-1-4  | Used on top port and side port leading to needle valves<br>Name in Protocol: NPT screws   |
| Stainless Steel Swagelok Tube Fitting, Port Connector, 1/4 in. Tube OD (x8)   | Swagelok                                   | SS-401-PC   | Use as tube connections between NTP and valve connections<br>Name in Protocol: port connector fitting   |
| <b>TANK</b>   |  |   |   |
| 1/4 OD in. x 20 ft. Copper Soft Refrigeration Coil  | Everbilt                                   | Model # D 04020PS   | For circulating coolant<br>Name in Protocol: 1/4" copper pipe   |

|  |             |                       |   |
|--|-------------|-----------------------|---|
| 10 gallon aquarium   | Tetra       |                       | Name in Protocol: 10 gallon tank  |
| 2 oz. Waterweld  | J-B Weld    | Model # 8277          | Name in Protocol: underwater sealant  |
| 3 in. x 25 ft. Foil Backed Fiberglass Pipe Wrap Insulation                     | Frost King  | Model # SP42X/16      | For wrapping around aquarium<br>Name in Protocol: foil-lined fiberglass                 |
| 3/8 7/8 in. Stainless Steel Hose Clamp (10 pack)                               | Everbilt    | Model # 670655E       | Name in Protocol: worm drive hose clamps  |
| Styrofoam  |             |                       | Name in Protocol: insulating material   |
| <b>TOOLS</b>   |             |                       |   |
| 1-1/8 in. Ratcheting Tube Cutter   | Husky       | Model # 86-036-0111   |   |
| 1/2 in. to 1 in. Pipe Cutter   | Apollo      | Model # 69PTKC001     |   |
| Adjustable wrench (x2)   | Steel Core  | Model # 31899         | Need two wrenches with jaw at least 1"  |
| Allen wrench set   | Home Depot  |                       |   |
| Duct tape  |             |                       | Name in Protocol: duct tape   |
| Flexible tubing, like an IV line, to fit on the end of grainger probe (canula) |             |                       | Name in Protocol: IV tube   |
| Grainger 18 gauge probe  | Grainger    |                       | For inserting droplet<br>Name in Protocol: cannula                                      |
| High Vacuum Grease   | Dow corning |                       | Apply to o-rings before inserting sapphire window<br>Name in Protocol: vacuum grease    |
| Klein Tools Professional 90 Degree 4-in-1 Tube Bender                          | Klein Tools | Model # 89030         | Name in Protocol: tube bender   |
| Snoop liquid leak detector   | Swagelok    | MS-SNOOP-8OZ          | To detect leaks when pressurized when methane<br>Name in Protocol: liquid leak detector |
| Suction cup  | Home Depot  |                       | For removing tight fitting sapphire window<br>Name in Protocol: suction cup             |
| Teflon Tape  |             |                       | Name in Protocol: plumber's tape  |
| Temflex 3/4 in. x 60 ft. 1700 Electrical Tape Black                            | 3M          | Model # 1700-1PK-BB40 | Name in Protocol: electrical tape   |