



12. PHASE CHANGE (THE GLASS TRANSITION)



“The deepest and most interesting unsolved problem in solid state physics is probably the theory of the nature of glass and the glass transition.” — P.W. Anderson

Glass is one of the most enigmatic materials in human civilization — ubiquitous, endlessly useful, and yet still a mystery to physicists, who continue to debate its true nature.

The many uses of glass are staggering to consider. Through the **lenses** of our **telescopes**, **microscopes**, **binoculars**, and **spectacles**, we use glass to help us see the very big and very small (and through **cameras**, to document our world). Through the **screens** of our **cell phones**, **televisions**, and **computers**, we use glass to inform, entertain, and communicate. Through our **fiber optic** cables, we use glass to carry the **Internet** under the ocean and across other great distances, enabling our **virtual worlds**. Through orbiting **satellites**, we use glass **mirrors** to send **data** back and forth to Earth, and to probe the limits of faraway **space**. Through the **windows** in our **homes**, **cars**, **trains**, and **airplanes**, we use glass to modulate our sense of within and without. Through the **faces** of our **watches**, we use glass to track our sense of **time**. Through our various **cups** and **vessels**, we use glass to measure, mix, cook, hydrate, celebrate, and cultivate romance. Through the **mirrors** in our homes, we use glass to reflect on our **appearance** and to observe our **bodies** as we age. Without the technology of glass, human life on Earth would be radically different.

In solid state physics, the so-called “**glass transition**” is the mysterious shift that occurs when a hard and brittle non-crystalline solid gradually becomes viscous, liquid-like, and “**glassy**” through a sustained increase in temperature. As this “glassy” material cools, it undergoes a process known as “**vitrification**” — retaining the amorphous molecular structure of a liquid while hardening into something that is effectively solid.

This paradoxical quality of being both a liquid and a solid at the same time is fundamental to the enigma of glass — it is **neither-nor**; it is **both-and**.

In this ritual, I work with **Ethan Bond-Watts** to build a handmade **cob furnace** in a hillside at **High Acres Farm**. We seek to use the furnace to transform the ingredients we gathered and prepared in *Apprenticeship* into our own homemade glass — incorporating the cremated remains of my mother, and other materials of our land.

We set out our collection of powders on a twenty-foot table made with maple slabs harvested from **Shelburne Farms** — our **silica** (from the Cheshire Quartzite); our **potash** (from the bonfire of my mother’s papers); our **limestone** (from the Shelburne quarry); our **linestone** (from the High Acres Farm beach); and my **mother’s ashes** (in Ethan’s handmade vase).

For the **crucible** to hold our ingredients, we use an old clay vessel which was gifted to Ethan by one of his mentors, and which was made at nearby **Goddard College** in the 1970s.

Our furnace has three distinct chambers: one to hold our wood and fire, one to hold our crucible, and one for annealing our glass. The doors of the latter two are made of clay, while the door of the wood chamber is made from the metal roof of the 1890s “**Old Dairy Barn**” at nearby **Shelburne Farms**, which was struck by lightning and burned to the ground during the time we were building our furnace.

To accelerate the airflow into the fire chamber, we insert an old High Acres Farm gas-powered “**Weed Eater**” leaf blower into a rusty eight-foot iron pipe — propping up one end of the pipe on a sawhorse, with the other end poking into the fire chamber of the furnace. In this way, we can protect the plastic neck of the leaf blower from melting in the powerful heat of the fire.



On **November 1, 2016** (the **Day of the Dead**), we light our furnace at dawn, and all day long we feed it firewood to help it gather heat, to the roaring sound of the leaf blower.

By nightfall, we've added our ingredients, and we take turns sleeping in shifts on the hillside, as the glass transition works its magic from within the heart of the furnace.

Around midnight, the fire is so hungry for oxygen that its flames are licking out of every available opening, including around the edges of the crucible chamber door, and through the small circular hole in the center of that door.

These wildly flapping flames, unplanned and unexpected, evoke a mythical **Phoenix** — the archetypal force of transformation, bursting forth from the crucible at the heart of our raging furnace.

Around 4:00 AM, an unfortunate crack appears in the crucible, and the molten mixture begins to leak away into the fire. The leaf blower suddenly stalls, and when we try to restart it, the cord breaks off, so it can't be started again. We assess our quickly changing situation.

Blurry-eyed and exhausted, we try to make a vessel before our molten glass is totally gone... As the first light of dawn appears in the east, we place a small glass cup in a bucket of **vermiculite** to cool — the "**phase change**" miraculously having succeeded.

We received two unexpected visitors bookending our night of glassmaking, each with an interesting name — in the evening, a local friend named Callie (as in **Kali**, the Hindu goddess of creation and destruction), and the next morning, my cousin **Lila** (the Hindu term for the dance of reality).

Performed in 2016 — Duration 12:50

