In nanoimprint lithography (NIL), an imprint resist is first spin coated on the surface of a substrate and then pressed against a rigid mold whose features are to be reproduced. Once the right pressure is achieved between the imprint resist and the template, the imprint resist is either subjected to a thermal treatment or a UV light treatment for curing depending on the type of resist. If a thermoplastic polymer is chosen as the imprint resist, it is heated above its glass transition temperature to soften and acquire the impression of the template. The template is then slowly separated from the imprint upon cooling. The acquired impression in the imprint is the negative replica of the template, which is further subjected to a pattern transfer process (usually by reactive ion etching just like photolithography) to transmit the imprinted pattern in the resist to the substrate. This nanoimprinting technique is termed as thermoplastic nanoimprint lithography (T-NIL) or hot embossing lithography (HEL), which was developed at the University of Minnesota by Dr. Stephen Chou’s research group in the mid 1990’s. In fact, the word nanoimprint lithography was coined by Dr. Chou’s group, which performed and reported the first studies on nanoimprint lithography, and later developed it into a manufacturing technology.

Very similar to this technique is the photo nanoimprint lithography (P-NIL), also called cold embossing or UV nanoimprint lithography (UV-NIL), in which a photoresist is used as an imprint material. The photoresist is either spin coated or dispensed with a scanning inkjet head (step and flash imprint lithography) on a transparent substrate, brought in contact with the template to maintain a certain pressure in between, and then cured by exposing to UV light. The photoresist undergoes crosslinking and hardens, and acquires the impression of the template after which they are slowly detached from each other. This step is also followed by a pattern transfer process to transmit the features from...
the imprint into the substrate. This technique was developed by Dr. Grant Willson’s research group at the University of Texas at Austin.

Schematics of T-NIL and P-NIL are shown below. Developed as a low manufacturing cost and high-throughput method to fabricate nanoscale features, the NIL technique was demonstrated to create features from 25-nm resolution up to sub-10 nm resolution, and was successfully applied to produce magnetic nanostructures, quantized magnetic disks, silicon field effect transistors, semiconductor nanowires, and nano-compact disks. Indeed, it was shown that NIL can be scaled up to fabricate large area patterns as well, and with further developments came several different versions of NIL, including hybrid techniques, commercial systems, and timely review articles.
Schematics of thermoplastic nanoimprint lithography (left) and photo nanoimprint lithography (right). Both the techniques use a polymer resist preplaced on a substrate that is pressed against a mold to get the impression of the pattern (either by heat or by UV exposure), and subsequently subjected to reactive ion etching to transmit the pattern into the underlying substrate. All the other known nanoimprint lithography techniques, such as roller nanoimprint lithography (RNIL) and jet and flash™ imprint lithography (J-FIL), are derivatives of these two techniques.