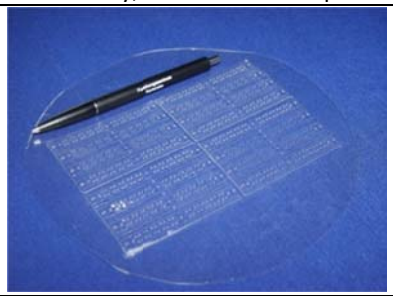
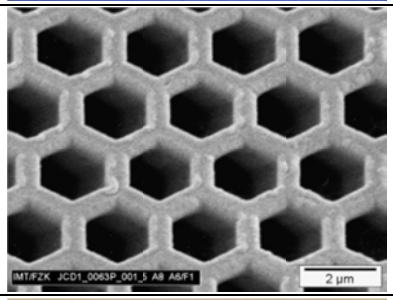
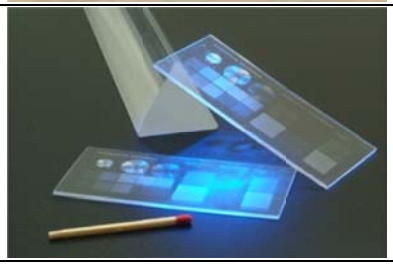
Replication

Polymer and nanoimprinting

Karlsruhe Institute of Technology (KIT), Germany

Contact:	**Dr. Matthias Worgull** Email matthias.worgull@kit.edu • Phone +49(721)608- 26828 • Fax +49(721)608- 24331						
Material class:	Silicon	Polymer X	Metal	Ceramic	Glass	Organic	Other
Short technology description:	Hot embossing is a replication process especially suited for the replication of delicate micro- and nanostructures structures with high aspect ratios on thin layers. Because of the short flow paths and the low shear velocities during molding the replicated structures are characterized by low inner stress. The process is very flexible, because both mold inserts and the type of polymer can be exchanged quickly, which is why hot embossing machines are very popular for laboratory use and for the replication of small series. Process: The hot embossing process is an open tool technique, where a semi-finished polymer sheet is put in between the upper and the lower molding tool. The complete tool is evacuated in order to ensure complete filling of the cavities of the microstructured tool, and the polymer is heated up above its softening temperature (melting temperature or glass transition temperature, depending on the polymer class). The softened polymer is pressed into the microstructured cavities. After mold filling, the polymer is cooled down below the softening temperature, while maintaining the applied force in order to avoid shrinkage and sinking marks. Finally, the machine is opened and the microstructured part can be demolded.						
Typical structures and designs:					**Replicated microstructures on an area of 8 inch**		
					**Replication of structures in the nano range (e.g. optical gratings)**		
					**Replication in semicrystalline high temperature polymers (LCP, PEEK)**		
					**Replication of small series (10 000) parts of diffractive and refractive optical elements (NEMO Edu Kit)**		

Special features:	– Cycle times 6 min – 20 min – Molding area up to 8 inch – Double sided molding (Alignment) – Molding of through holes – In general molding of all thermoplastic polymers, including high temperature polymers – Structure size down to the nano range (Nanoimprint) – Quick change of mold insert and polymer – small series and prototypes with different polymers
Limitations, constraints:	– Cycle times determined by heating and cooling times – Max. molding area of 8 inch depends on the available molding tool, larger sizes requires a new development – Fixation of mold inserts refers to standardized mold inserts and clamping units. Other formats require further modifications of the clamping unit
Material examples:	– Side wall draft angle if possible – Low roughness of the mold surface – No undercuts