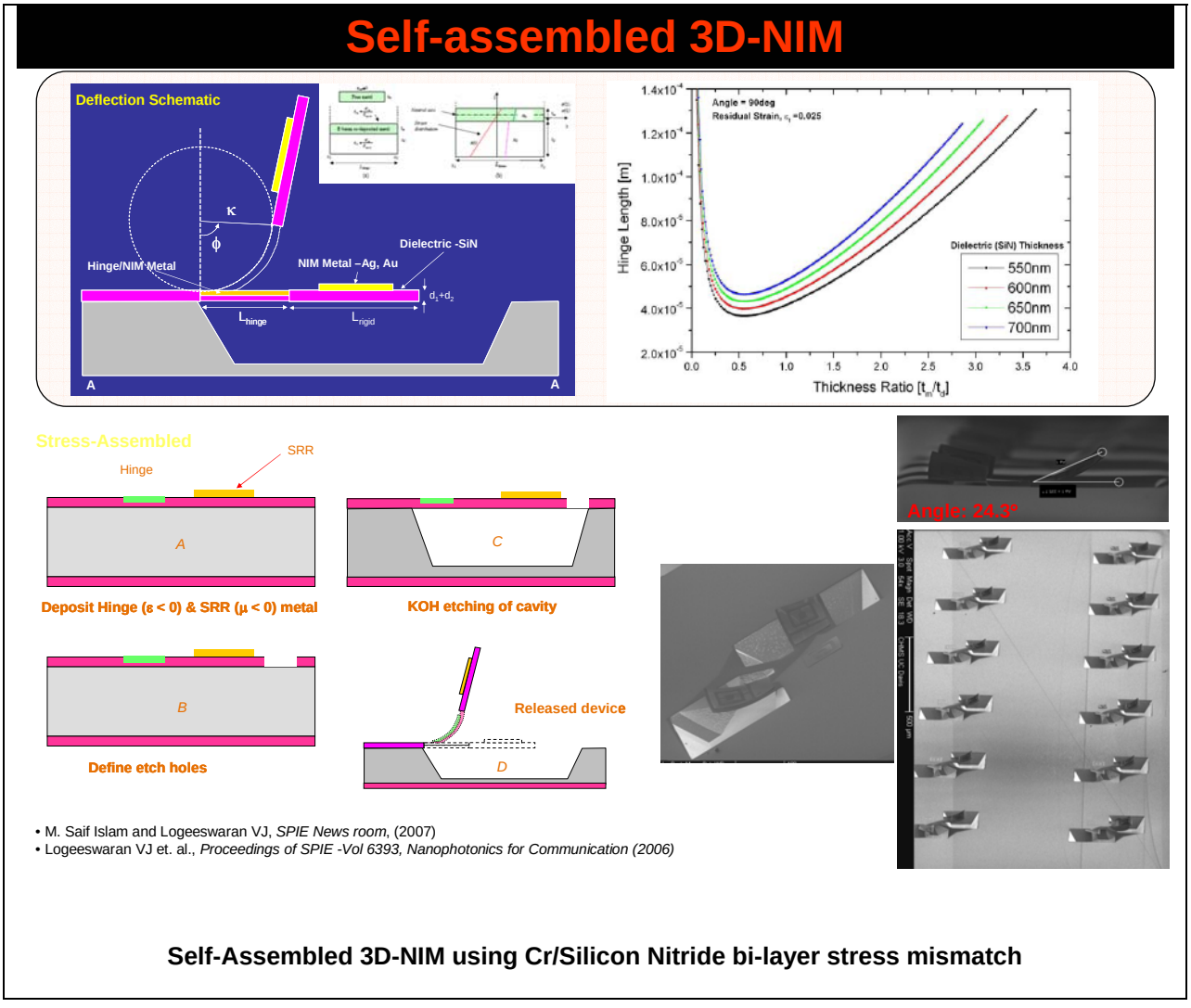
Microfabrication of self-assembling elements for 3D-Negative Index Materials

In this project, we are exploring microfabrication methods to realize three dimensional (3D) homogeneous negative index material (3D-NIMs) using a low cost and massively parallel manufacturable and self-assembly technique. The construction of self-assembled 3D-NIM array was realized through two dimensional (2-D) planar microfabrication techniques exploiting the as deposited residual stress imbalance between a bi-layer consisting of e-beam evaporated metal (chromium) and a structural layer of low stress silicon nitride deposited by LPCVD on a p-doped silicon substrate. A periodic continuation of a single rectangular unit cell consisting of split-ring resonators (SRR) and wires were fabricated to generate a 3D assembly by orienting them along all three Cartesian axes. The thin chromium and silicon nitride bi-layer is formed as hinges. The strain mismatch between the two layers at the hinge curls the structural layer containing the SRR upwards. The self-assembled out-of-plane angular position depends on the thickness and material composing the bi-layer. This built-in stress-actuated assembly method is suitable for applications requiring a thin dielectric layer for the SRR and/or active devices.



Self-Assembled 3D-NIM using Cr/Silicon Nitride bi-layer stress mismatch