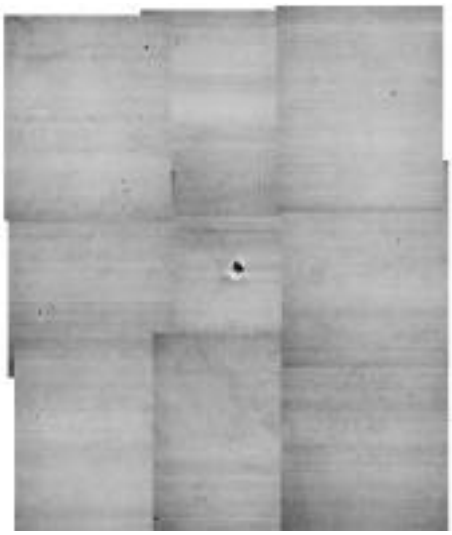
Naval Research Laboratory - Office of Naval Research
Materials Science and Technology
http://mstd.nrl.navy.mil

Science and Technology Success Stories

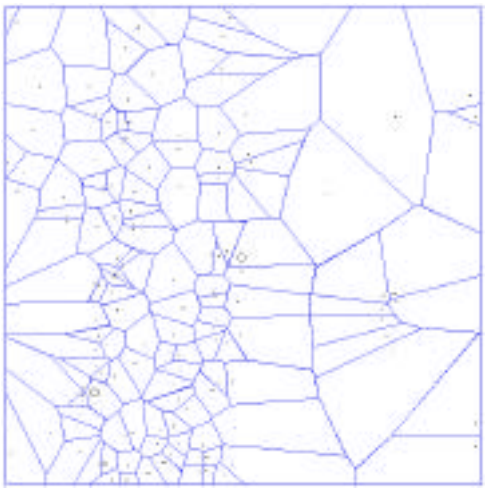
Ductile Damage Evolution in Naval Steels

The Naval Research Laboratory (NRL), the Navy's corporate laboratory, has a program in the characterization and simulation of ductile damage evolution in naval steels. An emphasis of this research is to develop integrated experimental and computational methodologies that will bridge the microstructural and macrostructural scales by quantifying the physical response of materials on the mesoscale.

The first step in the process involves the detailed characterization of the relevant microstructural features. These microstructures are used to produce realistic image-based finite element models. The stress and strain state information generated in the finite element models is analyzed and compiled into databases. These databases are then used by discrete cellular-based models that simulate the effect of the actual microstructures on the structural response of the naval steels. Comparison of the image-based models to the standard regular and random arrays shows differences by up to 50% in strain at a constant stress and 5% in stress at a constant strain.



Micrograph showing manganese sulfide inclusion distribution in HY100 steel



Tessellation of micrographs produces relevant statistical information

Ductile Damage Evolution in Naval Steels

Military Impact

- **Accurate Material Curves for Structural Analysis and Design Simulations**
- **Improved Predictive Capability for:**
  - **Structure Response Simulation**
  - **Damage Tolerance (Survivability)**
  - **Lethality**

Potential Civilian Spin-offs

- **Simulation Capabilities for:**
  - **Aerospace Structures**
  - **Automotive Structures**
  - **Bio-Medical Implants**
  - **Manufacturing Processes**

Point of Contact

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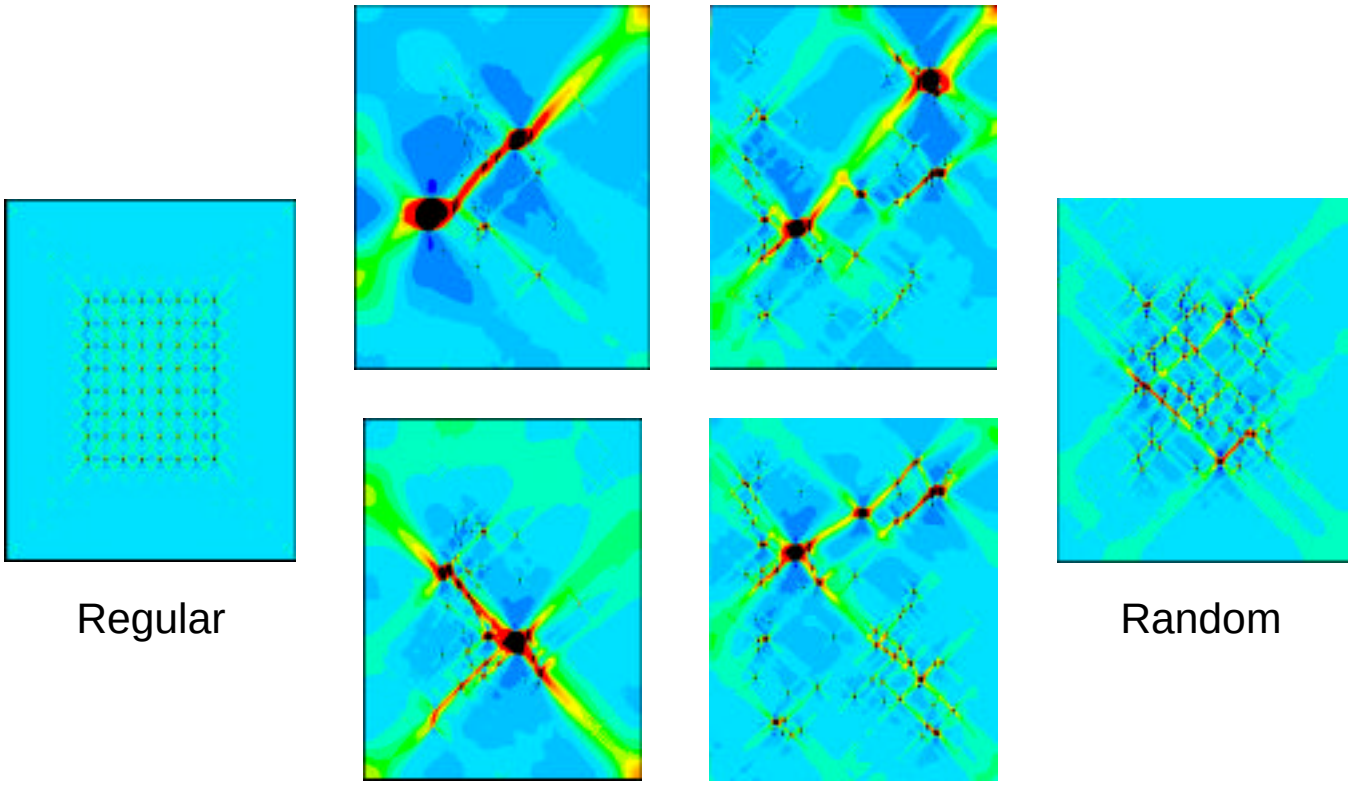

HY100 Steel Image Based

Comparison of finite element simulation using regular, image based and random arrays of manganese sulfide inclusions showing distinctive plastic flow localization patterns in HY100 steel