# Structure and strength in graded nanostructured steel

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**Session: L2, Venue: Palma (Room: E, F)**

**NANOMATERIALS FOR STRUCTURAL & ENERGY APPLICATIONS II**

**Session Chairs: F Rizzo, Brazil and Ivani Bott, Brazil**

**L2 Dec-02 14:10**
*Structure and strength in graded nanostructured steel
*Xiaodan Zhang, Niels Hansen, Yukui Gao, Xiaoxu Huang†*
*Danmarks Tekniske Universitet, Denmark*

**L2 Dec-02 14:30**
*Nd–Fe–B and Sm–Co/Fe exchange–spring films–model hard magnetic materials for electric power generation
*Yuepeng Zhang†, Charudatta M. Phatak, John E. Pearson, Yongseong Choi, Jidong S. Jiang, Nora M. Dempsey, Dominique Givord, Sakura Pascarelli*
*Argonne National Laboratory, United States of America*

**L2 Dec-02 14:50**
*Formation and characterization of hybrid nanodots embedded in gate dielectric for optoelectronic application
*Seiichi Miyazaki†*
*Nagoya University, Japan*

**L2 Dec-02 15:10**
*Nano-scale film surface control by advanced sputtering system
*Hirotaka Toyoda†*
*Nagoya University, Japan*

**L2 Dec-02 15:30**
*Multi–component nanoarchitectures comprised of inorganic and carbon nanostructures
*Nitin Chopra†*
*University of Alabama, United States of America*

Coffee / Tea break 15:50 to 16:10

**L2 Dec-02 16:10**
*Preferential oxidation of CO in hydrogen on PtCu nano particles supported on alumina
*Takayuki Komatsu†, Michiko Takasaki, Shinya Furukawa, Kenichi Ozawa*
*Department of Materials Science, Tokyo Institute of Technology, Japan*

**L2 Dec-02 16:30**
*Crystal chemistry of rare earth–borides with dimensional network structures
*Kunio Yubuta†*
*Institute for Materials Research, Tohoku University, Japan*

**L2 Dec-02 16:50**
*Nanostructure control of Si–based solar cells using plasma CVD
*Masaharu Shiratani†, Giichiro Uchida, Hyunwoong Seo, Kazunori Koga, Naho Itagaki, Kunihiro Kamataki*
*Kyushu University, Japan*

**L2 Dec-02 17:10**
*Antiferromagnet material for low–power consumption magnetic recording devices

* *invited presentation*

# Structure and strength in graded nanostructured steel

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The structure and strength of low carbon steel samples have been analyzed after plastic deformation by shot-peening and cold-rolling. The fine scale surface microstructure caused by shot-peening extends to ~50 μm below the surface. The structure is graded and subdivided by dislocation boundaries and high angle boundaries showing a clear resemblance to the lamellar structure, which evolves during conventional rolling of bulk metallic materials from medium to high strain. As the surface is approached, the boundary spacing decreases to ~50 nm at the surface. In parallel, the misorientation angle across boundaries increases to ~65% of high angle boundaries. The cold-rolled steel shows a low hardening rate at high strain and by assuming additive strength contributions from Hall–Petch and dislocation strengthening, the flow stress has been expressed by the relationship $\sigma - \sigma_0 = k_2 D_{av}^{-0.5}$, where $D_{av}$ is the average spacing between the low and high angle boundaries which subdivide the microstructure, $\sigma_0$ is the friction stress and $k_2$ is a number which is expressed in terms of structural parameters which have been determined by electron backscattered diffraction. It is found that calculated $k_2$ values are in accord with an experimental value of 310 MPa $\mu m^{0.5}$. In the shot-peened steel the increase in $D_{av}$ with increasing distance from the surface is transformed into a stress profile based on the $\sigma$ - $D_{av}$ relationship established for cold-rolled bulk samples. The calculated stress profile is validated by comparison with the experimental profile based on hardness measurements, and good agreement is found. This result points to a wider application of the suggested method to derive the local flow stress in a deformed microstructure based on a measurement of the local boundary spacing and the stress–structure relationship for the bulk material in the deformed state.

Reference:

[1] Hall–Petch and dislocation strengthening in graded nanostructured steel. Xiaodan Zhang, Niels Hansen, Yukui Gao, Xiaoxu Huang. Acta Materialia 2012; 60: 5933 - 5943.