DR. OLEG KOLOSOV
STATEMENT OF RESEARCH INTERESTS AND ACCOMPLISHEMENTS

Research Interests

- Microscale and nanoscale physical-chemical properties of materials. Mechanics and nanostructure of nanoscale devices.
- Nanoscale mechanical properties, elasticity and visco-elasticity, surface adhesion, stresses and mechanical microstructure of
    - polymers,
    - semiconductors,
    - biomaterials,
    - and nanocomposites.
- Nanosecond time phenomena in nanoscale devices. High frequency and microwave acoustics and spectroscopy. Time resolved scanned force microscopy of physical phenomena including
    - mechanical relaxation and resonances,
    - thermal relaxation and thermal diffusivity,
    - electrical, electronic and ferroelectric properties.
- Nanoscale ferroelectric domain dynamics and microstructure of ferroelectric materials, including single crystals, thin films, piezo-ceramics and polymer ferroelectrics (PVDF, P(VDF-TrFE).
- Measurement technologies for material studies on the length scale ranging from 10^{-3} to 10^{-9} metres, Scanning Probe Microscopy, Brillouin spectrosopy, Laser acoustics, Acoustic microscopy.
- Combinatorial material science and high throughput screening methods for optimization of polymeric and inorganic materials, and sensor development.
- Physical material property sensors for local physical properties of liquids and gases - viscosity, density, rheology and thermal. Sensors for the physical properties of bio-environmental interface, biofluids sensors.

Key Research Accomplishments

- Invented Ultrasonic Force Miscoscopy (UFM) and other scanning probe microscopy methods (1993).

UFM approach allowed for the first time to map mechanical properties of stiff materials (eg semiconductor superlattices, quantum dots, fiber reinforced composites, etc with the nanoscale resolution). Increasing number of academic and industrial research team using UFM approach for mapping mechanical properties of semiconductor materials, coatings, polymer interconnects.

- Pioneered manipulation of ferroelectric domains on the nanoscale (1994).

New technology turned out to be vital for the development of non-volatile high capacity ferroelectric memory – it is now widely used in most of the groups working in the field.

- Using UFM, first in the world directly imaged mechanical properties of hard materials with nanoscale resolution, including compound semicoductors, quantum dots, nanocomposites, subsurface delaminations and dislocations (1994 - 1999) and developed underlying theory.

One of the examples is the study of the delaminations in polymer barrier films (PET-Interlayer-OXIDE) for food packaging under stress. Another – is study of the mechanical properties distribution in stressed epitaxially grown Si-Ge quantum dots.

- Discovered and investigated "ultrasonic induced nanolubricity" – nanotribology on the nanosecond time scale.
- Using combination of picosecond laser acoustics and Scanned Probe Microscopy, I introduced mapping of surface and subsurface thermal diffusivity of nanostructures on the submicron level (1996-2003).
- Using combination of picosecond laser acoustics and Scanned Probe Microscopy, I introduced mapping of surface and subsurface thermal diffusivity of nanostructures on the submicron level (1996-2003).
- Successfully proposed and completed pump-priming project on the mexhanical properties of nanometre scale (20-40 nm) oxide layers on PET substrate between Oxford University, UK and Toppan Printing Company on food packaging nanocomposites, project leader within the Toppan Oxford Centre (1996).
- Invented family of high throughput methods for material properties measurements (4 granted patents, 20 + current patent applications).
- Using combinatorial discovery approach developed new materials for Biotechnology, Personal care, Electronic industry and Sensor Technology including:
    - Advanced polymers for high speed DNA separation.
    - Materials for electronic industry.
    - Nanodispersing materials for agrochemsitry and materials for bioactive deliveries.
    - Mini - sensors for in-situ measurement of fluid properties.
- Initiated and supervised technology transfer from industry (Symyx Technologies) to a University (North Dakota State University via EPScOR Grant to the Office of Naval Research, the largest technology transfer in NDSU history) (2001 - present).
- Created, secured funding and lead a research group on nanoscale measurement of materials properties at the Department of Materials, Oxford University, UK. (ranked top Materials Science department in UK).
- Pioneered mechanical micromapping of human tissues - medical microacoustic imaging - with the micrometer resolution using GHz frequency transmission acoustic microscopy (1989).