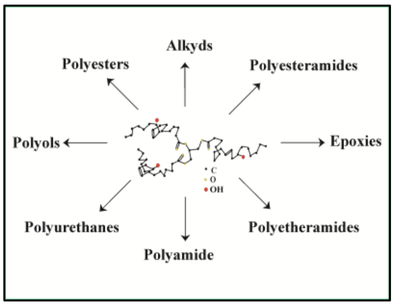
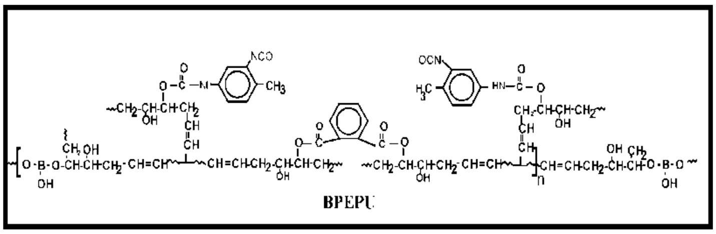
NAME OF SCHOLAR: DEEWAN AKRAM
NAME OF SUPERVISOR: PROF SHARIF AHMAD
DEPARTMENT: CHEMISTRY
TITLE OF THESIS: DEVELOPMENT OF CORROSION PROTECTIVE COATING MATERIALS FROM VEGETABLE OIL BASED POLYOL

ABSTRACT

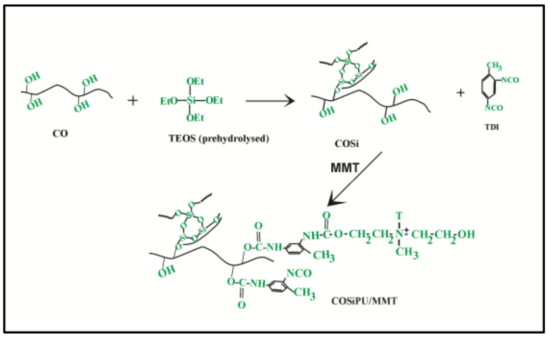
In the past two decades, research and development efforts in the field of coatings and paints have undergone colossal changes worldwide due to the escalating prices of petro-based chemicals, consumer expectations of good quality and performance coupled with lower cost, concerns related to energy consumption, environmental contamination (improper waste management, greenhouse effect, health problems), and regulations such as Clean Air Act Amendments [CAAA, 1990]. There has been growing demand in the paints and coatings industry towards the development of environment friendly, high performance, and cost effective coating materials. The ultimate solution is foreseen in the proper utilization of sustainable resources not only to cut off the increasing costs of the petro-based products, but also to produce environmentally benign, high performance value added formulations.

Literature reports the utilization of several renewable resources such as starch, cellulose, lignin, cashewnut shell liquid, rosin, vegetable oils [VOs] in the synthesis of films, packaging materials and as corrosion protective coatings. Amongst these, VOs have been extensively used as binders for surface coatings due to abundant availability, cost effectiveness, structural attributes, non-toxic nature and eco-friendliness. They yield several low molecular weight monomers/polymers such as fatty amides, epoxies, polyols, polyesters, alkyds, polyesteramides, polyetheramides, polyurethanes that find versatile industrial applications as biofuels, inks, lubricants, additives, adhesives, cosmetics, besides their use as coatings and paints. The drawbacks associated with the aforementioned systems are (i) multi-step synthesis process, (ii) multi-step cure schedule, (iii) cumbersome synthesis and curing processes (involving high temperatures and times), and (iv) use of substantial amount of hazardous VOC [volatile organic compounds]. ***In the thesis, an attempt has been made to develop some boron incorporated and "nanostructured" organic-inorganic hybrid coating materials involving simple synthesis and curing strategy at ambient temperature with VOs based, naturally available (Castor oil) and chemically synthesized (from Linseed oil) polyols*** *(*derived by the lesser explored reactions, the reactions occurring at double bonds of oil, i.e., by hydroxylation reaction). The thesis has been divided into seven Chapters as described further. *Chapter 1* entitled "**Introduction and Literature Review**" embodies general introduction of corrosion, corrosion related problems, various modes of protection, need as well as significance of the utilization of sustainable resources such as VOs, in the field of polymers and coatings. A brief introduction of some of the environment friendly technologies utilized in the development of VOs based "green" coating materials has also been discussed. *Chapter 2* on "**Characterization Methods and Techniques of Oils, Oleoresins and their Coatings**" summarizes various standard methods and techniques such as physico-chemical (epoxide equivalent, iodine value, saponification value, refractive index, specific gravity and hydroxyl value), spectral (FTIR, ^{1}H-NMR, ^{13}C-NMR), thermal (Thermogravimetric Analysis and Differential Scanning Calorimetry), morphological (Scanning Electron Microscopy, Transmission Electron Microscopy, X ray), physico-mechanical (scratch hardness, impact resistance and bend test), corrosion resistance studies (weight loss in various chemical media, salt spray test, potentiodynamic polarization measurements) and antibacterial behavior of the prepared coating material. In *Chapter 3* entitled "**Synthesis, Characterization and Corrosion Protective Performance of Boron Modified Castor (Natural Polyol) Polyurethane**", an attempt has been made to incorporate boron in the backbone of Castor oil [CO], a natural polyol, to develop boron modified polyesters [BCPE] and





polyurethanes [BPU], through “one-pot multiple-step reactions” achieving more than 50% reduction in the use of VOC. *Chapter 4* entitled “**Synthesis, Characterization and Corrosion Protective Performance of Boron Modified Linseed Polyol-Polyurethane**”, describes the structures and properties of linseed polyol, boron incorporated Linseed oil [LO] polyols [BPEP] and their polyurethanes [BPEPU]. BPEPU may serve as efficient corrosion protective materials which may be safely employed upto 230^{o}C. *Chapter 5* covering “**Synthesis, Characterization and Corrosion Protective Performance of Linseed and Castor Polyol-Polyurethane Organic-Inorganic Hybrid/Fumed Silica Nanocomposites**” describes the preparation of organic–inorganic hybrid materials [O-I] from VOs (LO and CO) polyols, through simple sol–gel chemistry, with CO and LO polyol [$COSi_{low}$ and $LPOSi_{low}$ = $O\text{-}I_{low}$], as organic precursors and tetraethoxyorthosilane [TEOS] as inorganic precursor (in different amounts, i.e., 0.4mol, 0.5mol and 0.6mol) followed by treatment with TDI and fumed silica, to obtain biohybrid coatings with minimal VOC and safe usage upto 240^{o}C. In *Chapter 6* entitled “**Synthesis, Characterization and Corrosion Protective Performance of Linseed and Castor Polyol-Polyurethane Organic-Inorganic Hybrids**”, an attempt has been made to investigate the effect of reaction temperature on the structure, morphology and coating properties of the organic-inorganic hybrid materials [O-I] derived from VOs polyols, CO and LO polyols. It was found that the reaction temperature has significant influence on morphology and coating performance of biohybrids. The thermal analyses revealed that these systems may be safely employed upto 220^{o}C. *Chapter 7* on **“Synthesis, Characterization and Corrosion Protective Performance of Linseed and Castor Polyol-Polyurethane Organic-Inorganic Hybrid/Clay Biocomposites”** describes the preparation, characterization and coating properties of CO and LO polyurethane/clay hybrid composites coating material, with excellent performance as corrosion protection materials and safe usage upto 220^{o}C.



Appendix I covers some suggestions for future research work

1. The thesis embodies the synthesis and characterization of some boron incorporated VOs based polyols, polyurethanes, organic-inorganic hybrids and composites. These materials have shown good physico-mechanical, corrosion resistance performance, thermal stability and antibacterial behavior. Some of the studies such as OCP measurements, EIS, PP studies at different concentrations of corrosive media, AFM, CV studies have not been covered in the thesis, which can be pursued as future area of research work.
2. These materials can also be subjected to toxicity evaluation, skin irritation tests and others.
3. One very important scope of the material is in the field of biocompatible coatings. This aspect can also be explored in future.
4. Other inorganic sol-gel precursors may also be used such as alkoxides of titanium, zirconium, and others.
5. The use of materials as biobased adhesives may also be studied as an alternate application.