Polymer Bulletin
https://doi.org/10.1007/s00289-018-2471-2

REVIEW

Modified silicone oil types, mechanical properties and applications

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Received: 17 June 2018 / Accepted: 28 July 2018

Abstract

Silicone oil is famous for its greater stability and high-temperature non-toxic use at low surface tension and high spreading power. It is the mixture of polydimethylsiloxanes (PDMS) with dimethicone and simethicone, therefore largely used in industrial products due to their unique properties like non-toxicity, high lubricity and stable film strips formations, and widely used in lubricants, electric insulator, laboratories, anti-foaming, etc. Silicone oil is chosen by improving their lubrication performance in mechanical system like resin, films, satellite and space vehicles. The purpose of this study is to design for evaluating and distinguishing feature of polydimethylsiloxane (PDMS) or silicone oil to show their mechanical and thermal properties. In industrial field, i.e., improved their adhesive and contact angle properties for their long time durability and stability. The aim of this review is to elaborate and distinguish the feature of polydimethyl siloxane (PDMS) or silicone oil to show their mechanical and thermal properties showing the shinning properties and importance of silicone oil in daily routine and in industry. Also silicone oil and there derivates like polymethyl hydrogen siloxane, amino silicone, phenyl methyl silicone, vinyl silicone and hydrogen silicone oil play a key role in curing agent, hair-care cosmetics and shampoos and thermostat fluid anti-adhesion processing. Materials which we have used in this review such as polymethyl hydrogen siloxane, amino silicone oil, phenyl methyl silicone oil, vinyl silicone oil and hydrogen silicone oil show significant and potential properties in various fields of industries. Different types of methods like cross-linking, copolymerization and coupling agents were used in different reactions in this review. Also synthetic types of compounds were also used for different properties giving excellent results. This review highlighted the beneficial aspects of silicone oil in various fields. Silicone oil shows prominent properties like lubrication, smooth gliding behavior, wettability, mechanical strength, mechanical stability and high-performance coating. Silicone oil is also useful for decreasing surface tension and retaining the moisture.

Keywords Silicone oil · Mechanical properties · General applications

Extended author information available on the last page of the article

Published online: 07 August 2018

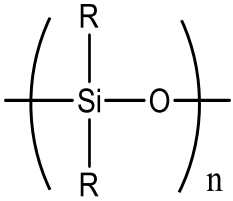


Fig. 1 General structure of PDMS

Introduction

Silicone oil has been used from the very begging in the industrial field as well as refer to linear polymers, where R = Me or polydimethylsiloxane (PDMS) or –Si–O–Si–O–Si–O–. Figure 1, General structure of polydimethylsiloxane (PDMS).

Structures of polymer can be represented by M, D, T and Q monomers letters. Straight chain silicone mostly contains D units. Presently, silicone is obtained commercially from chlorosilanes prepared from the direct process of Rochow [1]. Silicone oil is famous for its higher stability and temperature like UV radiation with low surface tension and high spreading power, good dielectric properties with low temperature, depending on their physical properties [2]. Sometimes, it is also called as "inert'' fluids for polystyrene (PS); PS specimens are immersed in oil for very short period (~0.5) [3]. Silicone oil is equipped with a combination of their physical and chemical properties that have propelled their use in health field [3]. Silicone oil is largely used in industrial products due to their unique properties like non-toxicity, high lubricity and stable film strips formations [4]. Therefore, silicone oil is chosen by improving their lubrication performance in mechanical system in many satellites [5]. The standard silicone oil is lighter than the natural water, and specific gravity is slightly higher than that of water [6]. Silicone oil is the representative mixture of polydimethylsiloxanes (PDMS) with dimethicone and simethicone [6]. Silicone oil is used for filling the cable termination because it has used in wide level in this field for the last two three decades [6]. Fluorosilicone plays an important role for standard silicone elastomers, because these elastomers are quite different from the fluoroelastomers processing [7]. Sometimes, the term "hybrid'' is also used for silicone to differentiate them from alkyl chain. R is included between two Si atoms from the classical siloxane with OSiO enhancement [8]. Also importance use of silicone oil is environmental friendly lubricant, which can be easily recycled and relatively non-hazardous chemicals, because they contain thermally stable properties. On the other hand, silicone oil film breaks down easily in electrohydrodynamic condition. Such phenomena are induced by non-Newtonian behavior of silicone oil, when applied to materials [9]. Often employed as a continuous phase in electro-logical fluids due to their low polarizabilities, such as van der Waals force and steric repulsion which helps in the micro-solid particles phase, which maintain yield stress, shear thickening and thixotropy [10]. It has been used as comonomer in fluorosiloxane polymer, wave sensor for sensing of dimethyl methylphosphonate (DMMP) [11]. Having low temperature, aircraft industry uses more fluorosilicone than fluorocarbon elastomers, which is required for airplane at high altitude [12]. According to IUPAC rules,

silicone is known as polyorganosiloxanes [12]. In LASER technology, silicone oil shows much more resistance and shows no cracking, good thermal resistance and shows transparencies in the range of UV rays [18]. High-quality shampoos and conditioners contain silicone oil for hair-care products [13], because large bond energy silicone oil is thermodynamically more stable and high polarized [13]. For control of glass wettability silicone, oil has been used [14]. Low relative polarizabilities in continuous phase in electro-rheological fluids silicone oil are usually employed [14]. Silicone oil is dispersive synthetic polymers, i.e., consist of linear structure with many chain size of low molecular weights [15]. PDMS or silicone oil also helpful in the preparation of tectonic modeling community provides a viscous model deformation for rocks in the earth crust and mantle [16]. Amino silicone oil is used for the modification of natural fiber because it smoothly absorbed on the surface of natural fiber and make the surface of the fiber soft, smooth, elastic and anti-wrinkle [16].

The purpose of this mini review is to design for evaluating and distinguishing the feature of polydimethyl siloxane (PDMS). Silicone oil shows their physical, chemical, thermal and mechanical properties. In industrial field, i.e., improved their adhesive and contact angle properties for their long time durability and stability. Although some review papers have been published which describe the modification and application of the modified silicone oil, some aspects of chemical modification and applications of modified silicone oil are still not described in detail.

In this review, we have focused our discussion on the chemical modification of silicone oil and its applications as an industrial level, and try to make much more useful techniques in the modern technological age like space and LASER fields. Searching the best way for improving and enhancing all this properties.

Advantage of this review is to elaborate and distinguish features of silicone oil to show their mechanical and thermal properties showing the potentially properties and importance of silicone oil in our daily life and in industry level. Also silicone oil derivates like polymethyl hydrogen siloxane, amino silicone oil, vinyl silicone oil and hydrogen silicone oil play a key role in curing agent, hair-care cosmetics and shampoos and thermostat fluid anti-adhesion processing. Synthetic types of compounds were also used for different properties giving excellent results.

Types of silicone oil

Polymethyl hydrogen siloxane/hydrogen silicone oil

Polymethyl hydrogen siloxane oil (C_3H_9OSi-$(CH_4OSi)n$-CH_3H_9Si) is mainly colorless, odorless oily liquid used as a water proof and anti-sticking treatment agent, as a liquid silicone rubber's chain extender, hot forming curing agent, and as cross-linker and improves products' elongation at break. Polymethyl hydrogen siloxane oil connected with functional groups like epoxy group and improved

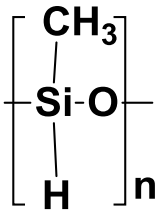


Fig. 2 Polymethyl hydrogen siloxane

the reactivity, absorption behavior and coupling properties of that particular substance [17]. Figure 2, Polymethyl hydrogen siloxane.

Amino silicone oil/amino silicones

Amino silicone oil is applied in textile finishing. Series of amino silicone oil can be obtained satisfactory from wool cotton and chemical fiber. In emulsion form, it provides strong adsorption for the polyester blended yarn, nylon and can tightly combine with active group of fibers. This type of oil plays key role in hair-care cosmetics and shampoos. However, it should be kept away from fire [17]. Figure 3, Amino silicone oil.

Phenyl methyl silicone oil

Phenyl methyl silicone oil is important kind of safe chemical having special properties like insulation and anti-ozone containing small surface tension and wide working temperature scale from − 50 to + 250 °C. Phenyl methyl silicone oil can be used as hydraulic liquid and heat carrier at high temperatures [17]. Figure 4, Phenyl methyl silicone oil.

Vinyl silicone oil

Vinyl silicone oil is an excellent and lively intermediate material. Product contains methyl. Silicone oil common performance such as smoothness, limpness,

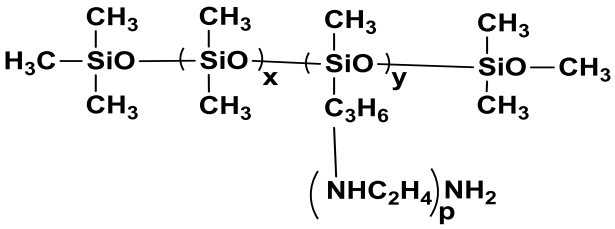


Fig. 3 Amino silicone oil

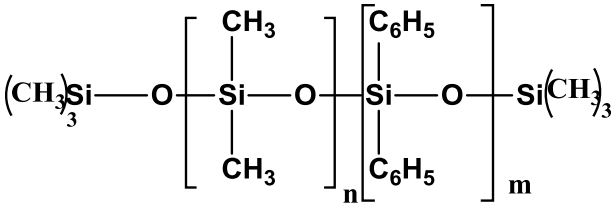


Fig. 4 Phenyl methyl silicone oil

bright, etc. The interesting point of this type of oil is that it reacts easily with organic material such as polyurethane and acrylic acid, etc. Moreover, it is the main material of liquid silicone rubber [18]. Figure 5, Vinyl silicone oil structure.

Hydroxy silicone oil

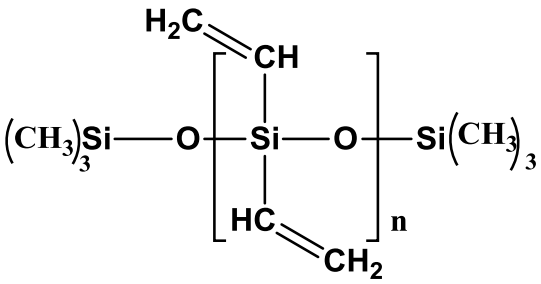
Hydroxy silicone oil is a transparent liquid commonly used in textile industry having outstanding electric insulator, with high flashing point, large comparison ratio and low surface tension properties. Moreover, it is also used in the anti-adhesion processing of complexity quality paper and as major ingredient of leather smooth ring agent and brightening agent; however, it can be mixed with heated water and alkali substance, etc. [18]. Figure 6, Hydroxy silicone oil.

Mechanical properties of silicone oil

Heng, Z.G., et al. studied epoxy silicone copolymers prepared from methyl phenyl silicone intermediate. Silicone is modified with epoxy resins having greater elongation at break and impact strength than neat resin. TGA result showed thermal stability at 600 °C increased with the increase in siloxane content. Adding silicone oil enhances the reducing properties when checked by DMA test [19]. Figure 7, Modified epoxy resins.

Mu, L., et al. reported preparation of ternary silicone sponges through facile sol gel method using methyl trimethoxysilane (MTMS), tetraethylorthosilicate (TEOS)

Fig. 5 Vinyl silicone oil structure



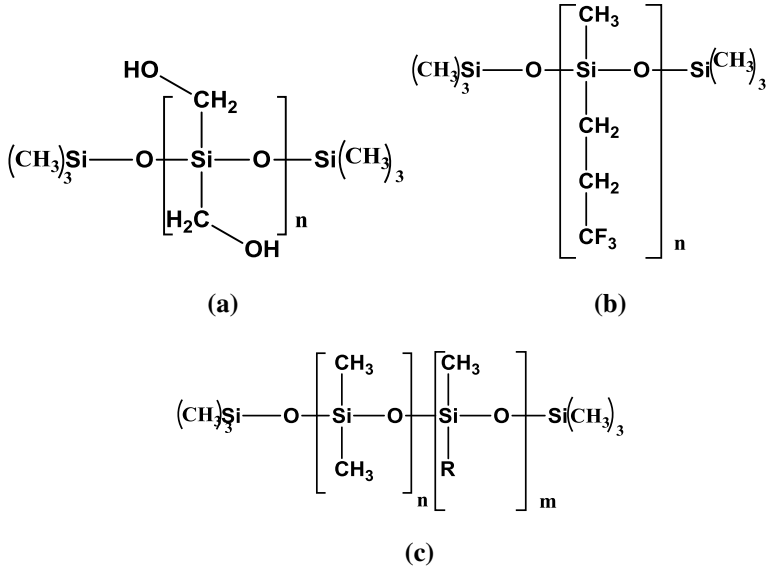


Fig. 6 Schemes of chemical structure of **a** hydroxy silicone oil, **b** trifluoropropylmethyl silicone oil and **c** methylalkylsilicone oil

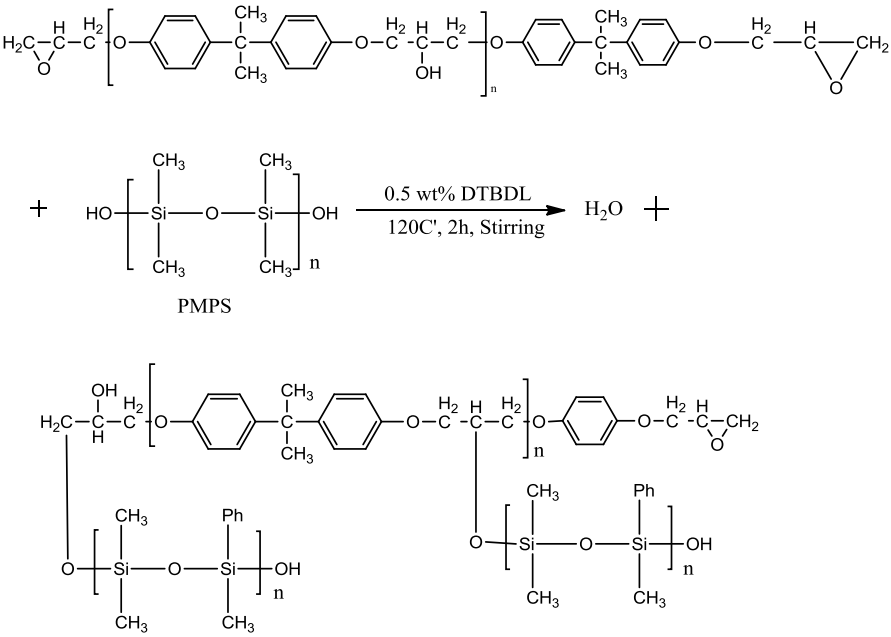
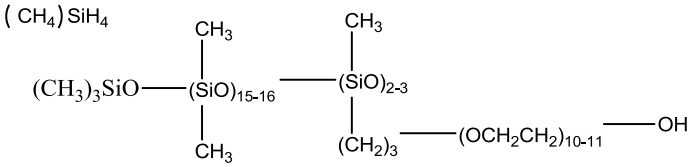


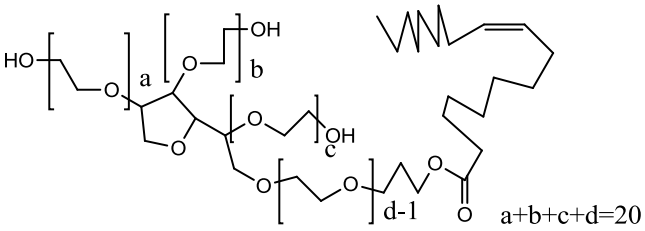
Fig. 7 Modified epoxy resins

and dimethyldimethoxy silicone (DMDMS). Result shows that immersing of tetraethylorthosilicate (TEOS) into binary silicone sponge shows higher cross-linking reaction as demonstrated by chain-like structures. These samples enhanced mechanical properties and thermal stability of the materials. Excellent structure and thermal stability of the optimized sponge make it an ideal candidate to be used in the separation industry [19]. Cao, E. P., et al. selected vinyl silicone oil to prepare the ceramic silicone rubber composites. Cross-link structure of silicone rubber with and without HVSO was studied. Mechanical properties of composites were enhanced by the formation of this cross-linked network. It shows that HVSO improved the properties of silicone rubber composites [20]. Kim, S. R. and D. J. Kim et al. added two types of silicone oil polydimethylsiloxane (PDMS) and poly dimethyldiphenyl siloxane (PDMDPS) to polycarbonate (PC). The neat PC impact strength at −30 °C was 8 kg_f cm/cm, which increased to 52 kg_f cm/cm with the addition of PDMDPS. Greater chemical affinity and response of the phenyl group in the PDMDPS led to the high impact strength of the PC. With low temperature, no remarkable decrease occurred in other thermoplastic polymers [20]. Hu, X. M., et al. studied effect of surfactants of foaming behavior of phenol urea formaldehyde. Silicone oil and tween-80 surfactants were selected to study their effects on mechanical properties of the foams. It was concluded that the optimum content of surfactants was an important factor, obtaining higher mechanical properties and uniform cells of phenol urea formaldehyde foam [21]. Figure 8a, Silicone cosmetic oil DC-193 Transparent silicones hair oil Fig. 8b, Tween-80 surfactants.



DC-193

(a)



Tween-80

(b)

Fig. 8 **a** Silicone cosmetic oil DC-193 Transparent silicones hair oil, **b** tween-80 surfactants

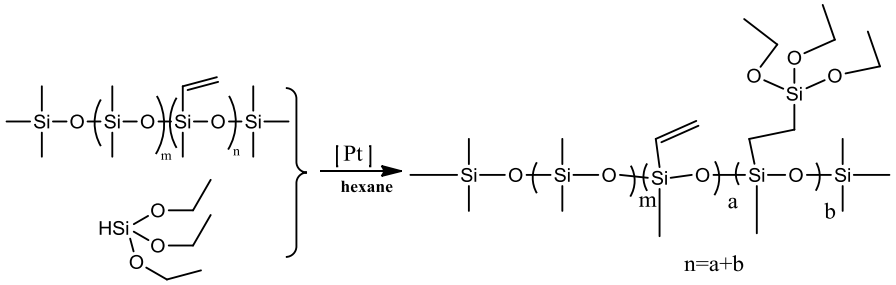


Fig. 9 Allyl-capped hyper-branched polycarbosilane

Mei, H. G., et al. used two types of vinyl silicone oil having allyl-capped hyper-branched triethoxysilane and polycarbosilane to synthesize macromolecular silane coupling agent by hydrosilylation. They were used for improving the fragile mechanical properties of silicone rubber. SEM and cross-linking density test improved interaction between silicone rubber and fumed silica. Furthermore, mechanical properties of the resulted composites by using macromolecular silane coupling agent (MMSCA) were increased to varying degrees measure with those possessing cross-linkers without ethoxy group. Ethoxy group can increase toughness of silicone rubber by reacting off partial vinyl group of the macromolecules [21]. Figure 9, Allyl-capped hyper-branched polycarbosilane.

Mu, L., et al. studied and proved that silicone oil is the most typical base materials with their excellent thermal stability and contact angle [21]. Yang, J. H., et al. focused on the extensional flow properties of silicone oil, and they found that there are many properties which are helpful for industrial process such as injecket printing, spraying and coating [22]. Zhang, W., et al. reached at the conclusion and found that silicone oil has excellent thermal stability and good heat transfer characteristics because for very long time silicone oil is used in laboratories, in refrigerants, etc., also highly soluble in toluene and xylene, in chlorinated hydrocarbons, and therefore, it is also used as a good solvent for non-polar compounds [22]. Zhu, S., et al. synthesized liquid crystalline molecule 4-allyloxy-biphenyl-4-ol (AOBPO) checked with the fluorescence spectroscopy, Fourier transform infrared spectroscopy, thermal gravimetric analysis and thermal conductivity were improved to be 3.105 W/(mK) at the mass fraction of 15–0%, which was enhanced more than 38 times over that of neat silicone resin which are widely used mechanical variety of electronic packaging applications [23]. Imiela, M., et al. emphasized on characterization of ceramic structure generated during heat treatment and thermal properties of the composites. Scanning electron microscope (SEM) and compression strength of the ceramic structure were deliberated. These demonstrated that increasing carbon fibers amount improves the mechanical properties [23]. Tao, Y., et al. studied the properties, i.e., thermal and mechanical for central processing unit (CPU) and for octavinyl polyhedral oligomeric silsesquioxane (POSS). Result have focused studying nanoscale POSS and structural property relationships in copolymer with > 15% POSS. We examine that the cubic POSS can improve both properties of central processing unit (CPU)

[24]. Xu, D. W., et al. synthesized silicone toughened unsaturated polyester reacted monomer copolymerization of anhydrides and diols with hydroxyl-terminated silicones. Checking their mechanical properties, fracture surfaces studied by scanning electron microscope (SEM) and dynamic mechanical analysis were also used. Result showed the impact strength of silicone toughened unsaturated polyester improved through copolymerization with a small amount of silicone. Comparing with those of unsaturated polyester, this method gives great benefit in absorbing a large amount of impact energy [24]. Tambe, C., et al. prepared reactive blends from methoxysilane terminated silicone polymer with silylated soybean oil. Hydrolysis of the methoxysilanes and subsequent condensation of the resulting silanes yields stable siloxanes linkage between two immiscible phases. Swell-gel analysis, FT-IR and TGA show effective formation of those siloxanes cross-links. Depending on the composition of elongation elastomers and modulus resins, these reactive blends shows higher properties [25]. Zhang, M. J., et al. studied thin silicone films as dielectric electroactive polymers (DEAP). Such silicones contain vinyl-terminated polydimethylsiloxanes. Cross-linked with tetrafunctional methylhydrosiloxane-dimethylsiloxanes copolymer, different vinyl groups were observed. Significant increase is observed in elastic modulus and permittivity that occurred at critical load conditions [25]. Cao, E. P., et al. reacted high vinyl silicone oil (HVSO) for preparing the ceramic silicone rubber composites. Cross-linked network of silicone rubber was studied for mechanical properties. Checking with scanning electron microscope (SEM) and dynamic mechanical analysis (DMA) showing enhancement of tear strength, tensile strength and elongation break of the composites were increased, respectively. Showing result high vinyl silicone oil is useful for improving the properties of silicone rubber composites [25]. Zhang, C., et al. studied three different types of silica with varied loading for mechanical and thermal properties of silicone rubbers. Fillers and polymer dispersion affected the mechanical properties. Filled fumed silica shows higher tensile strength and elongation at break compared to those containing two types of precipitated silica. Also it is noted that fumed silica and silicone oil loading were giving good result in mechanical properties [25].

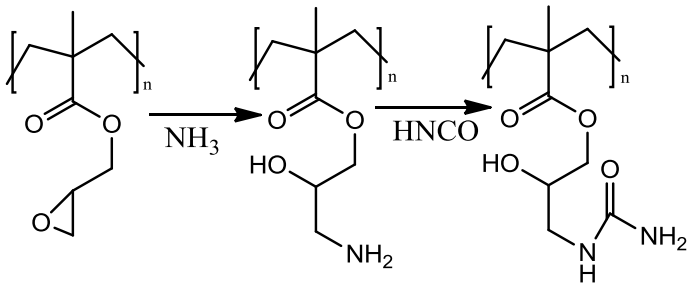


Fig. 10 Modification of poly glycidyl methacrylate *co*-ethylene dimethacrylate

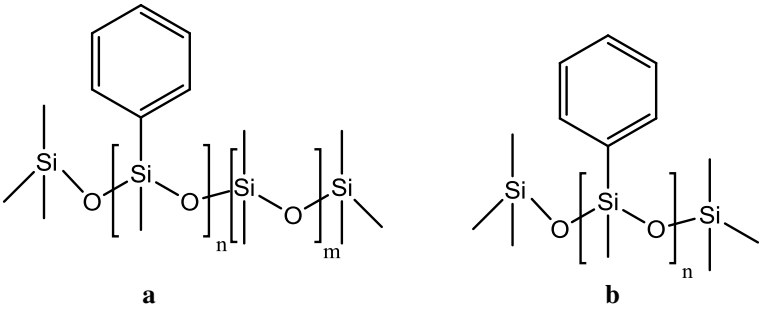


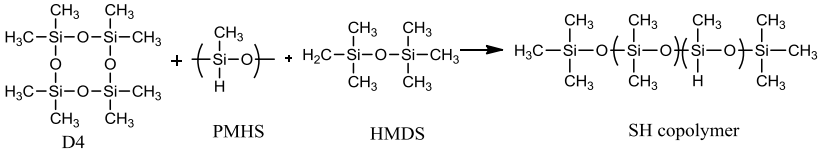
Fig. 11 **a** Phenylmethyl dimethylsiloxane copolymer oil **b** phenylmethyl siloxane homopolymer oil

Application of the modified silicone oil

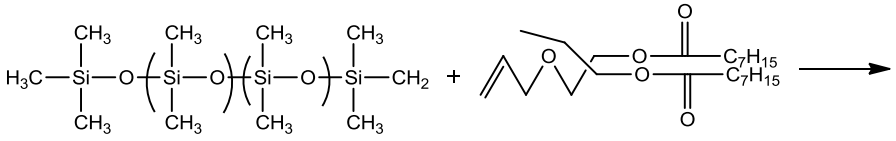
Belza, T., et al. studied modification of poly glycidyl methacrylate *co*-ethylene dimethacrylate microsphere with urea, testing their electro-rheological property. Functional urea groups were immersed by chemical modification with the starting copolymer. It shows remarkable increase in storage modulus in silicone oil suspension. Compared with the less modulus, an electric field is applied [26]. Figure 10, Modification of poly glycidyl methacrylate *co*-ethylene dimethacrylate.

Galhenage, T. p., et al. used silicone oil in siloxane polyurethane fouling release coating. Phenyl methyl silicone oil shows improvement in the fouling release performance. Overall modifying siloxane fouling coating mix with small amount (1–5 wt% basis) of phenyl methyl silicone oil shows excellent performance in specific laboratory like biological assays and in long-term field analysis [27]. Figure 11a Phenylmethyl dimethylsiloxane copolymer oil and Fig. 11b Phenylmethyl siloxane homopolymer oil.

Hou, X., et al. studied and stated many faults that happen in space craft caused by tribological difficulties. For this purpose, silicone oil is chosen to improve the lubrication performance of mechanical system in many satellites and rockets. Fluorosilane surface-modified LaF_3 nanoparticles successfully prepared through modification mechanism, because fluorosilane surface-modified lanthanum fluoride (LaF_3) nanoparticles as a lubricant can effectively improve the friction reducing and anti-wear ability as well as lead carrying capacity of fluorosilane oil under the optimum concentration [27]. Shi, W. X., et al. worked on nano-dendrite silica substrate. Silicone oil modified super hydrophobic port. It showed higher anti-cell adhesion capability and form distinguishable cell micro-patterns when size was greater than 50 μm. Obviously, no cell migration was noticed. Such platform can be used to culture different cells. It developed the way for constructing kind of biochips for biological assays and tissue engineering [28]. Song, Y., et al. worked on super hydrophobic nanofiber film, and they collected some very good result because they prepared nanofibers film by electrospinning consisting of ester-modified silicone oil precursor solution. The fibers were found having definite mechanical strength, which had great importance to the research of large diameter fibers with super hydrophobic surface. Also this method is convenient for environment [28]. Figure 12, SE copolymer.



Equation.1



Equation.2 **AEDD**

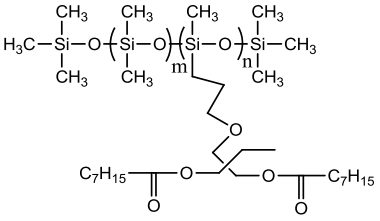
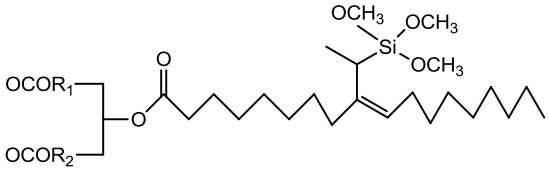
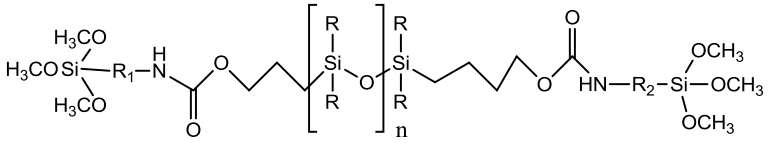


Fig. 12 SE copolymer



(a) Silylated soybean oil



(b) polysil-UR

Fig. 13 **a** Silylated soybean oil. **b** Polysil-UR

Tambe, C., et al. prepared reactive type blends from methoxysilane terminated silicone polymers and silylated soybean oil. The products were found as safety coating additives to adhesives for new sealants, like packaging, coating and agriculture applications [29]. Figure 13a Silylated soybean oil Fig. 13b Polysil-UR.

Luo. B. C., et al. studied modified silicone oil with poly (vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) fabricated the films by molding and casting methods. Permittivity was increased, while dielectric decreased for all blend films. Maximum discharged energy density was obtained, and result showed excellent interactions and compatibility between (PVDF-HFP) and silicone oil. Such films with dielectric energy show flexibility, and density may be potential in energy application [30]. Liu, X. Q., et al. synthesized a novel bio-based polyurethanes (PUs), modified with (PUs) hydroxyterminated dimethyl silicone (HTMS) used for coating urea prills. From experimental results, the presence of HTMS in PUs reduced the coating porosity and increased the water contact angle of the coating materials, also improved the structure and properties of coating materials for controlled release. This bio-based PUs made excellent coating material after HTMS modification [31]. Shi, W. X., et al. demonstrated that environmental friendly strategy to fabricate cell micro-patterns substrate separated by modified silicone oil super hydrophobic barriers shows excellent anti-cell adhesion capability forming distinguishable cell micro-patterns. No obvious cell migration was observed. Such types of geometry and shape of liquids via different parameters masks under UV irradiation can be used for culture multiple substrate [32]. Jiang, X., et al. modified vinyl silicone oil (VSO) with polyacrylate latex by emulsion polymerization. Shell-core structure was observed on transmission electron microscopy. High softening effect of VSO is proved by the

Table 1 Applications of silicone oil

S. no.	Applications	References
1	Used as a protein formations	[33]
2	Used in microwave atmospheric plasma jets	[34]
3	Provide a relief stress pattern to the films	[35]
4	Widely used as a lubricant in syringes to ensure a smooth gliding behavior	[36–39]
5	Widely applied in industrial products	[40]
6	Play a key and primarily in hydraulic fluids role	[41]
7	Excellent improvement showing in wettability and mechanical strength	[41]
8	For long and high temperature they show excellent mechanical stability	[42]
9	Widely used in high-performance coatings	[42]
10	Shows adhesion strength and hydrophobicity	[42]
11	Employed in the form of emulsion	[43]
12	Used for high-quality shampoos and conditioners	[43]
13	Used for dopamine as a coating materials	[44]
14	Applied as a spinner onto the pretreated sample surface	[45]
15	Reducing the coating porosity and increased the water content angle	[46]
16	Reducing coefficient friction	[47]
17	Good solvent for non-polar compounds	[48]
18	Decreasing the surface tension	[48]
19	Provide a base for mineral oils	[49]
20	Beneficial for moisture preservation	[50]

application of the latex as a binder pigment printing on textile. These printed fabrics show synthesized shell-core latex used as binder textile [33].

Some other applications are listed in Table 1.

As we have mentioned the application of silicone oil earlier, here giving much more information about the table, Tween@ 80 helps in the protein formation with the silicone oil, giving protein aggregation and particle formation [33]. Silicone oil also has the potentiality in the microwave atmospheric plasma jet, used to fabricate hydrophobic glass [34–36]. Silicone oil provides a relief stress pattern to films; Ni films deposited on silicone oil surfaces by thermal evaporation method have been studied systematically [37]. Nowadays, silicone oil is widely used as a lubricant in syringes to ensure a smooth gliding behavior especially in the field of pharmaceutical [38–40]. It is widely applied in industrial products like (ARISTO) silicone spray, industrial silicone lubricant, silicone oil polymerized siloxanes, type 200 fluid silicone oil, etc. [41]. It plays a key role in hydraulic fluids such as universal hydraulic fluid, silicone brake fluids, hydraulic jack oil, etc. [42]. It also shows excellent improvement in wettability and mechanical strength [43], and for high-temperature silicone oil it shows excellent mechanical stability [44]. It is also used in high-performance coating like helmar H400 silicone oil and silicone gun oil-35 which give a high-quality finish to gun and accessories repelling moisture dirt and fingerprints [45]. It shows long-term adhesion strength and hydrophobicity [46, 47]. Silicone oil also employed in the form of emulsions in personal care products due to their inert nature such as antifoam FDP antifoam emulsion, Loctite 770-NC frekote, etc. [43, 48]. Silicone oil also provides a high-quality shampoos and conditioners such as silicone hair treatment oil, max wonder GRO hair and body moisturizer and silicone proteina de perla shampoos, etc. [43]. Silicone oil also used as a dopamine for coating materials [44]. It also applied as a spinner onto the pretreated sample surface [43]. Also reducing the coating porosity and increased the water content angle [46]. Silicone oil also reducing coefficient friction, good solvent for non-polar compound decrease the surface tension like BT-3393 types of silicone oil used for hair coloring, fluorine silicone oil widely used in textile, paper and polymer, etc. [47, 48]. Silicone oil provides a base for mineral oil such as super lube direct food contact oil, KY-2500 silicone-based oil, antifoam agents and clear white mineral oil–liquid paraffin use for external use only [49]. Silicone oil is also beneficial for moisture preservation like silicone free skin care moisturizer, aveeno active natural smart essential moisturizer and salon style moisturizer, etc. [50].

Conclusion

In this review, we focus on silicone oil which is famous for its greater stability and high-temperature non-toxic use at low surface tension and high spreading power. Mixture of polydimethyl siloxanes (PDMS) with dimethicone and simethicone is largely used in industrial products due to their unique properties like non-toxicity, high lubricity, electric insulator, laboratories, and anti-foaming and stable film strips formations, and widely used in cosmetic, skin care cream, rubber, plastic, latex, etc.

Silicone oil is chosen by improving their lubrication performance in mechanical system like resin, films, and satellite and space vehicles. The purpose of this study is to design for evaluating and distinguishing the feature of polydimethyl siloxane (PDMS) or silicone oil to show their mechanical and thermal properties.

Also silicone oil is known as cyclosiloxanes which has so many properties, i.e., relatively highly volatility which is used in cosmetics products such as antiperspirant. For distillation or fermentation, excess amount of foam makes problematic. Ingredients like silly putty along with boric acid is commonly used like in polyurethane foam. It has also the advantage of silicone oil that is used in health like vitreous fluid playing a key role in treating difficult cases of retinal detachment such as complicated proliferative vitreoretinopathy, large retinal tears and penetrating ocular trauma. Silicone oil also showed excellent anti-cell adhesion capability and form distinguishable cell micro-patterns, when size was greater than 50 μm no obvious cell migration was observed. This platform can be used to culture multiple different cell types on the same substrate. Others functional groups, such as hydrogen, alkoxy, amine and higher number alkyl groups can also be introduced both to the side and to the end group of silicone oils.

In fact and shortly we can observe that silicone oil has unlimited advantages and provided a knee interest in every field of life, specially in industrial products, pharmaceutical products, machineries, household instruments and also common uses utensils in every day routine and not only that but increases day by day there application gain more and more attention.

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